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The Manufacture of Photographic Lenses

Being a Report on the Present State of the Art as Practiced by the Eastman Kodak Company, at Its Hawkeye Works, Rochester, New York

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MR. GUILFORD was born in Leicester, England, in 1887 and received his education mainly at the Leicester Technical School (now the Leicester Technical College), following this with a special study in optical science at the Imperial College of Science and Technology, London.

R. S. GUILFORD

From that time onwards Mr. Guilford has been very closely connected with the glass working, and particularly the lens making activities, of several firms. For twelve years he was with Messrs. Taylor, Taylor and Hobson, the makers of the well-known Cooke Lens and its modern derivatives. (Readers of THE GLASS INDUSTRY will recall that Mr. Lee, who recently reviewed the trend of design of photographic lenses, is also connected with that firm.) Then for two years Mr. Guilford worked on the making of microscope lenses with Messrs. R. and J. Beck, of London. For the last eleven years he has been with the Eastman Kodak Company, first as superintendent of optical production and now as assistant manager of the optical plant.

His experience in the two countries with the foremost firms in their lines especially qualifies him to review modern practice in the field on which he speaks in our present issue.

THE most important change that has been made in the manufacture of photographic lenses, is the almost exclusive use of molded lenses. This is the result of greater precision in the art of fine annealing of glass. Before and during the Great War molded lenses were not always uniformly annealed so that many makers of high grade lenses preferred to cut lenses out of the blocks of raw glass. This was wasteful with glass but produced uniform results. Research and mechanical control of temperature has removed the objections to molded lenses.

Another change has been the division of labor. Each operator now performs a comparatively simple operation on a large number of lenses.

Several attempts have been made to mechanize the processes so that the dominating human factor could be reduced or eliminated, but the results have not been encouraging.

The Eastman Kodak Company has need of a great number of lenses ranging from the simple finder lens found in the box type camera up to the huge compound lenses used in aerial survey work. The total number of lenses is immense but at the same time the number of types and sizes is also high. There are approximately 120 types and sizes in regular production beside hundreds of types made in small numbers for special purposes. The cost of production of these lenses varies from a few cents to thousands of dollars. It should be obvious therefore that no one form of procedure would be suited to such a varied line of product.

We are organized so that one molding shop serves three grinding and polishing shops, each established to produce a certain quality and type of lens; an edge grinding department and two assembly departments—the one for general products and the other for highest grades of product. With this set-up, there is no fear of the operator handling high grade work being influenced by the less exacting methods used on the cheaper types.

Each of our products is carefully examined under the conditions in which it is going to be used by the public and our tolerances and specifications are made to meet these conditions. For example a lens that is going to be used in aerial photography has exceptional atmospheric conditions to contend with and it also has exceptional physical conditions to withstand the vibrations while in the plane and the possibility of damage by impact while being handled. The cost of equipping a plane for aerial survey work is so great that no expense can be spared in making the lenses and their

mountings as perfect and exact as the highest grade of mechanic is capable of doing. On the other hand a single lens for a box camera can be produced with far less exactness and still produce wonderfully good pictures under reasonable lighting conditions.

THE MOLDING OF GLASS CUBES INTO DISCS

The first requirement of a lens plant is a scientific and computing department. The process of developing new types of lenses is a combination of high mathematical skill together with years of experiment and observation. The trend towards faster lenses and special lenses calls for constant investigation into the possibilities and limitations of every type of lens known and experiments with new types. This exacting work calls for a mixture of theoretical and practical knowledge which is very difficult to find in one person. After an optical formula has been designed and by means of samples, proved to be suitable for the particular requirements, the engineering department have to design a mounting to carry the lens system and to fit it to the camera or other instrument it is to work in. It is in this engineering department that limits and tolerances are fixed, in cooperation with the computing department, so as to make sure of meeting all demands that are put upon it. The necessary tools, fixtures and jigs are next designed.

The process department in cooperation with the works superintendent are next called upon to lay out a series of processes that will produce most economically the desired article.

The optical glass is purchased from the makers under strict limits as to refractive index and dispersion. We ask for the refractive index to be within $\pm$ .0010. It is also important for the glass to be free from strain, and as free as possible from color, bubbles and other defects. Each consignment of glass is checked for index with the maker's statement and the computing department give the storekeeper a statement as to what this glass can be used for. If a batch of glass is really close to the theoretical requirements the batch is ear-marked for the highest grade lenses, while if it varies from the theoretical requirements but at the same time is within our limits, it is marked for use on lenses of small aperture that will not be sensitive to such variations. This division is necessary because the glassmakers cannot guarantee the optical properties of glass as accurately as our needs require.

In connection with the properties of glass it might be mentioned that our lenses have many varying climatic conditions to contend with and the instability of some types of glass gives us much trouble. Our lenses are taken to the Arctic regions and to the tropics, they go to dry climates and to damp climates, and our customers are within their rights when they expect the lenses to perform correctly under all conditions. Lieut. George W. Goddard of the Photographic Section, U. S. Army, says in recent aerial work in the Philippine Isles at 12,000 feet elevation the sponge rubber suits they were wearing could not keep out the intense cold. From this altitude they drop down to the tropical heat and Lieut. Goddard says, "The camera equipment got as

THE POLISHING OF ANASTIGMAT LENSES

wet as if we had been parked out in a rain storm." Our representatives in the Panama Zone complain that frequently a fern-like growth will spread over the lens surfaces and so disfigure the lenses that they must be returned to Rochester to be repaired. From this it will be recognized that we are not at all satisfied with the weathering properties of optical glass and we have been experimenting for some time in the hopes of discovering some method of treating the surfaces of lenses to reduce the effect of weathering. Some success has already been obtained. Barium crown and dense flint glasses have been found to be unstable.

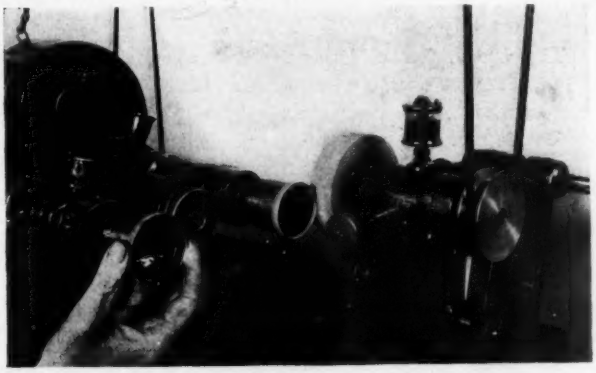
Owing to the great variety of product there is no standard process for our lenses, obviously the processes to produce a cinematographic lens 3.0 millimeter diameter is likely to be different from the processes used in producing lenses of 200.0 millimeter diameter. It is therefore necessary to mention two or more methods of procedure.

Our first requirement is to make rough discs. This can be done by cutting the slabs of glass into cubes by means of a steel glass cutter or the glass can be sawed into cubes by means of diamond-set saws. These saws are thin discs of

soft iron some 18 inches in diameter and $\frac{1}{16}$ inch thick, the outer periphery of which is set with fine diamond dust. The saws run in a lubricant to reduce friction. The glass is held in a wooden-jawed vise during this process.

The cube can be converted into a disc by edge grinding the periphery to the desired diameter or can be molded to shape. The molding process is used wherever possible because it is more economical. Small gas heated furnaces, built of fireclay, are used, and heated to about 1,600° F. The cubes are carefully laid in the furnace, so that no two are touching each other. As these cubes get hot they tend to soften and when they show by observation that they have reached the necessary plasticity the cube is withdrawn from the furnace, dropped into a die of the required shape, and placed under a punch operated by compressed air. This punch descends upon the glass in the die and shapes the upper surface to the required curve. To insure discs of the required thickness it is sometimes necessary to weigh each cube before molding and chip or grind away excess material.

The discs are now in a suitable shape to commence the grinding processes but first an annealing process must be

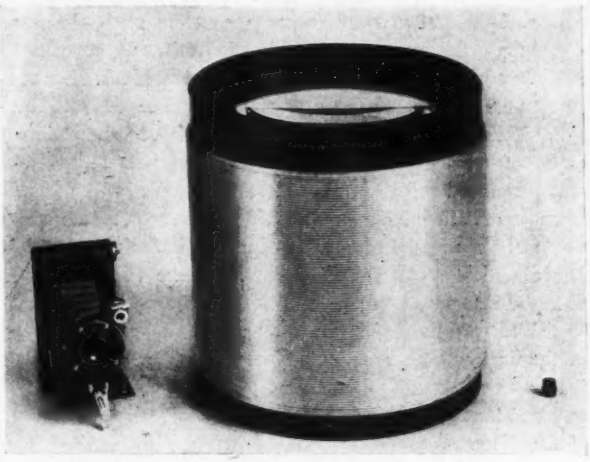


THE EDGE GRINDING OF POLISHED LENSES

performed to remove strain which is always present after molding. Large furnaces, electrically heated and electrically controlled for temperature, are used. Only one type of glass can go into a furnace at one time because the annealing temperatures vary with each type of glass. After filling an annealing furnace the doors are closed and the temperature is very slowly raised to a predetermined maximum, held at this maximum for some hours and then slowly reduced until after some five days processing the doors can be opened and the discs found to be free from strain.

The discs are now inspected for bubbles, folds in molding process, seeds, striae, and strain. These discs are not transparent so they are lowered into suitable liquids which increase the transparency. A strong beam of light passing through the liquid and disc will show most of the defects. A polariscope is used to test for strain.

We are now ready to rough-grind our discs to the shape and size required. Since we use only spherical surfaces we have iron shells whose surfaces have been accurately turned to a curve, the counterpart of the curve we wish to produce on our discs. That is to say, to produce a convex curve of 25.0 millimeter radius upon our discs we grind the discs upon a concave shell of 25.0 millimeter radius. The shell is held and revolved in a vertical spindle, suitable abrasive applied and the disc pressed against the shell. The abrasive can be in the nature of diamond dust impregnated into the surface of the shell, but more often is of emery or carborundum grit mixed with water. If the discs are large they may be handled individually but if of reasonable size and if the curvature allows, the discs are "blocked." That is to say



LEFT TO RIGHT, A VEST POCKET KODAK, A LARGE AERIAL LENS, A CINEMATOGRAPHIC LENS

the discs are arranged on the surface of one shell suitably shaped and held by means of wax, and the whole shell full of discs is then handled as though it were one large disc. In grinding the flat side of the finder lenses we hold some 900 finders to a shell and then handle them as though we had one large disc of some 15 inches diameter. The holding shell is usually recessed upon its surface so that each disc fits into a recess and with a small amount of wax it is secure for the necessary grinding and polishing. The discs are moved about the surface of the grinding shell by hand or by mechanical means and the abrasive changed from coarse to fine grit until the discs are of the required thickness, and the required fineness of surface. Four or sometimes five grades of abrasive are used to produce this fine surface.

Quite elaborate machinery has been devised to generate curves on discs somewhat after the way an automatic grinding machine generates forms, but these methods have not appreciably cheapened the cost of production.

The machinery we use for grinding and polishing may be described as follows: Let the left hand be clenched into a fist, representing a convex blocking shell having discs secured to its upper surface. The open right hand placed over the left and moved about forming the ball and socket motion represents the grinding or polishing shell. Long rows of such machines are used as each operator will control one or more spindles, in some cases 160 spindles are controlled by one operator.

For the regular run of work the one surface of the disc is ground and polished and then a similar process is used for the second side. For lenses of large aperture, where we have to maintain an accurate control of the axial thickness, the process is altered. After grinding the first side the lenses are removed from the blocking shell, turned over and re-

blocked upon another shell, ground on the second side and the central thickness corrected to one-hundredth of a millimeter. The lenses are blocked again for polishing each side.

Polishing is divided into two types, wax polishing and felt polishing. In felt polishing we replace the grinding shell by a shell of suitable curvature having a piece of heavy dense felt secured to its spherical surface. Rouge and water take the place of grit and water, the action being the same as in the grinding. Felt polishing is quick and produces a high lustre to the lenses, but slight imperfections of curvature make it unsuitable for any but the cheapest of photographic lenses. In wax polishing we line our shell with a layer of wax molded to the required curve. Rouge and water are used as in felt polishing. This layer of wax acted upon by frictional heat and the ball and socket action of the machine tends to a true spherical form, even slight irregularities found on a new polisher are quickly ironed out. The composition of this wax has to be very nicely adjusted to suit the temperature of the room and the weight of the upper member of the polishing machine. A wax that is too soft will tend to flow and so lose the sphericity required and one that is too hard will refuse to iron out to the curve of the discs.

After some five minutes of polishing the block is removed from the machine and tested for curvature by means of a test plate. This is a disc of hard glass ground and polished accurately to the counter curve of the curvature of the lenses being polished. If this test plate and one of the lenses of the block are thoroughly cleaned and placed in contact, interference rings or Newton rings are seen, and from the formation of these rings we are able to judge the accuracy of the curve. If this test is conducted in monochromatic light or under a Cooper-Hewitt light, greater accuracy is obtained. A variation of one thirty-thousandth of an inch is easily detected. We now decide whether the block was ground within the necessary limits of curvature, and inform the operator who is doing the fine grinding of the result of our test, so that he can alter the curvature of his shell to keep future blocks within the limits allowable and then after altering the adjustments of the polishing machine to suit each particular case, polishing is resumed. A longer stroke of the upper member will tend to a stronger or short radius of curvature while a short stroke tends to a weaker or longer radius. Such changes have to be made very gradually otherwise the resulting curvature is not spherical. The test plate is used periodically during polishing so that by the time the lenses are thoroughly polished the curvature will be within the required limits. We speak of one ring work, two ring and three ring work according to the number of interference rings allowable, which of course depends upon the sensitiveness of the formula and the accuracy required.

The polishing time varies from about one hour up to a full day according to the size of the block and the type of the glass. Hard glass will stand greater pressure in polishing and therefore polishes quickly but soft glass has to be polished with a minimum weight and therefore takes much time in polishing. There is a strict limit to the pressure that can be applied in this polishing. If the temperature of the lenses is raised, expansion takes place, and owing to the irregular shape of the lenses the expansion is irregular and this causes distortion of the surfaces.

When the polishing is finished the blocks of lenses are inspected by experienced inspectors for surface defects, scratches, "grey"[1] and curvature, the test plate being used again for this purpose. If the block passes through this inspection it goes to the removers who by heat remove the lenses from the shell. The second surface is ground and polished as the first surface was, but greater attention must be given to the central thickness.

After polishing, the lenses have to be handled carefully to avoid scratching. This is managed by keeping the lenses in slotted trays, each pair of slots arranged to hold the lenses in a vertical position and at a safe distance from one another.

The lenses are next taken to a different department where they are cleaned and inspected individually. This is done under different supervision so that there shall be no tendency to pass lenses of doubtful quality. It is cheaper to reject the doubtful lens at this stage rather than allow further labor to be expended on it with a possibility of its being rejected at the final inspection.

The cheaper form of lenses that are made out of common crown glass are washed in an alkaline bath. The lens trays are lowered into a warm agitated alkaline bath, then into warm clean water. The anastigmat lenses cannot go into this cleaning solution as the surfaces are more sensitive.

All lenses are next cleaned individually by hand to remove the last traces of wax and rouge.

Inspection comes next and is done under Cooper-Hewitt mercury lamps and with the aid of magnifying glasses, the surfaces and the interior of each lens are inspected and passed or rejected according to different standards for the various types of lenses. All rejected lenses and a certain percentage of the passed lenses are re-inspected to ensure a common quality. Without this re-inspection we should find that our fifteen inspectors had fifteen different ideas of quality. The central or axial thickness is measured and must be within certain pre-arranged limits. The rejected lenses are sorted into three groups. For scrap, for molding to a smaller size or for repolishing, according to the nature of the defects.

The next process is edge grinding. The discs are molded to a diameter of about two millimeters above the final diameter required, and it is necessary to grind the periphery down to this diameter and at the same to make the new periphery co-axial with the two polished surfaces. This is a delicate matter and very necessary, because the finished lens may be composed of three, four or six optical elements assembled in a mounting and unless all elements are upon a common axis the completed lens would be useless.

The edge grinding machine is composed of a horizontal spindle, or a turret carrying several spindles. The chuck for holding the lens is composed of a brass tube slightly smaller in diameter than the final lens diameter, turned true on the spindle. The chuck is warmed by means of a Bunsen burner and sealing wax is smeared over the end of the chuck,

[1]Grey means traces of the original grinding marks.

the lens is warmed and placed in contact with the wax on the chuck. If the spindle be now allowed to revolve and we look into the lens on the chuck, we see images of surrounding objects moving about. The lens and chuck are slightly warmed and the lens moved upon the chuck until it is in such a position that both images seen in the lens are stationary. When this has been accomplished we know that the axis of the lens coincides with the axis of the spindle. It is usual to have a definite target to observe rather than the surrounding objects, and when the surfaces are very strong, which means that the image will be very small, a microscope is used to insure accuracy. A grinding wheel is now brought into contact with the edge of the lens and it is ground down to finished size. The grinding wheels are of copper set with diamond dust or are carborundum wheels. The diameter of most of our optics must be such that they pass through a "go and not-go" gauge set with a tolerance of three hundredths of a millimeter, about a thousandth of an inch, so that the edge grinding machine, especially when composed of a four spindle turret, must be in very accurate condition.

The lenses are again washed, cleaned, and inspected and re-inspected and if passed as satisfactory are ready to be assembled into mounts.

It is not proposed to described the manufacture of the lens mounts here. They are usually of brass except where weight is of importance, when aluminum is used. They are roughed out on automatic screw machines and finished on optical precision lathes. They are japanned and engraved. A description of the manufacture of shutters and iris diaphragms must also be omitted here.

A complete photographic lens is usually composed of a front mount, and a back mount, each carrying one or more optical elements, and a barrel or shutter into which the two mounts are screwed.

The assembly of lenses necessitates extreme cleanliness. Each optical element is first placed into its seating and tested for fit, it is then removed and cleaned with alcohol, blown clear of lint and dust by compressed and dried air, and placed into its seating. It is secured in its position by means of a lock ring or by spinning the mount over the edge of the lens. This last method is the cheaper one, but care must be taken that no strain is introduced by undue pressure, and it can only be used with small lenses.

There are several tests for the completed lenses. The most critical test is the lens bench. A small source of light seventy feet away from the lens bench throws a parallel beam of light through the lens held in a clamp on the bench. A microscope behind the lens magnifies the image two hundred fold. The source of light can be changed to any of the primary colors so that chromatic aberrations can be measured. The lens can be revolved on a vertical axis and slides enable one to move the lens so that it revolves on its Gauss point when the oblique aberrations can be measured.

We take photographs with a small percentage of the lenses using certain test charts and views which are arranged to be just on the critical limit of resolution, which means that a good lens is just capable of producing clear images of the objects, but a lens of inferior quality will show a distinctly blurred image.

The new 16 millimeter Cine Kodak is fitted with removable lenses and five different types of lenses can be purchased for use on these cameras. This means that every lens of these five different types must be so accurately made to standard measurements that it can be placed on any one of the thousands of such cameras made and must produce satisfactory pictures. When it is considered that these are all very fast lenses, that is they have large apertures, the largest being Fl. 9 the precision required calls for the very best in both testing instruments and in personnel.

NOTE—The machinery used by the Eastman Kodak Company in the various processes described in the foregoing is mostly of the Company's own design and manufacture.

Books

The Year of Ceramics and Glass for France, *Annuaire des Céramistes et Verriers de France* 1930. Published in France by J. Hogrel, 13 Rue des Petites Ecuries, Paris (X°). Price (abroad) 50 francs.

The 1930 edition, published early in the year, of this very complete and carefully edited year book contains reliable lists of the French glass and ceramic manufacturers, dealers, agents, importers, exporters, etc. It is obviously a valuable volume for any concern desiring to develop its foreign trade. It is easy to use because of its methodical and practical classification. The method of presentation is irreproachable. We find in it all the data relating to ceramic and the glass industry, associations, syndicates, experts, trade-marks, and a large number of lists that have been compiled with great care, giving the user the addresses and information that he will need.

The Department of Commerce, Washington, D. C., announces that a one-reel educational motion picture on the production and utilization of asbestos is available for exhibition by schools, churches, clubs, civic and business organizations, etc. Applications should be addressed to the U. S. Bureau of Mines, Experiment Station, Pittsburgh, Pa. No charge except for transportation is made. Principal sources of asbestos on this continent are the mountains of Arizona and the area surrounding Asbestos, Canada. Asbestos is utilized to a considerable extent in the glass field for among other things as a heat insulator for furnaces and for pipe coverings, etc.

Copyright Bill Advanced

The Vestal bill for general copyright revision was passed in January in the House at Washington by a vote of 185 to 34. It was sent to the Senate and the general opinion of those interested in the bill at the time was that it would be put through the Senate promptly. The present copyright law was enacted in 1909 and efforts have been made during the past several years to make radical and much needed reforms.

Under the new provisions, the author without any formalities upon completion of creative work establishes his ownership of copyright. The author or owner of the copyright is given clear legal title to separate rights within his copyright privilege for magazine, book, motion picture rights, etc. The copyright is extended for the term of 56 years after publication to the life of the author for 50 years after his death, a practice which has been general throughout the rest of the world. Adherence of the United States to the Berne convention will without formality accord to American authors an automatic copyright in all of the 40 member countries of the International Copyright Union. The provisional copyright now owned by newspapers, book and magazine publishers, motion picture owners, and theatrical copyrights, etc., expire August 1, 1931, and unless the United States enters the Union by that date American authors and industries arising out of copyrights will have little if any protection of their work abroad after that date.

The Term "Pounds of Glass per Pound of Coal" Is Misleading

By JOHN W. ROMIG *

ONE of the much discussed terms in glass manufacturing is "Pounds of glass per pound of coal" or in the oil fired plant it is "Pounds of glass per gallon of oil fuel." The discussions are often serious and the common result of discussions is for some one to raise the question why one furnace or tank gives less glass per pound of fuel than another. Or the question arises—"Why is not the home organization producing as much glass per pound of fuel as some other manufacturers?" At any rate the term "Pounds of glass per pound of fuel" or the opposite, "Pounds of fuel per pound of glass" does not have any particular significance unless some other factors are given consideration.

Factors entering the picture—factors that must receive

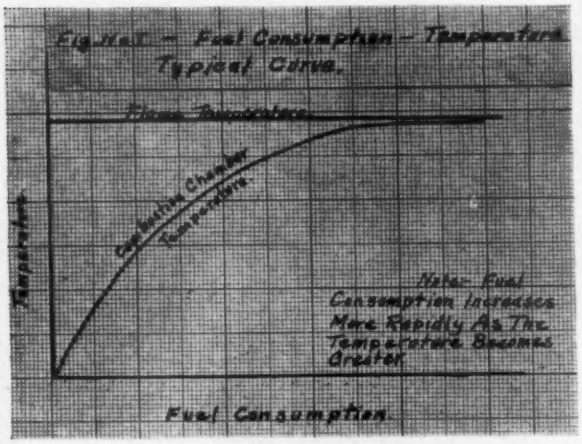


FIG. 1

consideration when discussing this term or any melting efficiency term on the basis of glass melted in tanks are as follows:

1. Furnace construction—capacity.
2. Regenerative capacity.
3. Temperature in tank.
4. Quality of fuel.
5. Pull on tank.

If some one comes home after a tense convention and reports that So and So is melting more glass per unit of fuel than is being done at the home plant, the part that the melting department can play in meeting an exceptionally good figure is limited unless operation of producers is poor and fuel is being wasted. The five factors above mentioned have, in most cases, a greater bearing on the melting ratio than operation.

While no actual figures are presented, it is generally conceded that a large tank will be more efficient than a small tank. A large tank will have less exposed area in proportion to capacity than a small tank. On the other hand, if a tank having an exposed glass area of 400 square feet is 10 feet wide and 40 feet long the sidewall periphery is 100 feet. If the tank is 20 feet by 20 feet the sidewall periphery is 80 feet. In the latter case there is 20 lineal feet less sidewall exposed than in the former.

Extra exposed sidewall furnace surface dissipates heat from the interior and for constant equal pulls from the two tanks the fuel consumption will be greater for the long tank. High and low crowns increase or decrease areas of exposed hot radiating and connecting surfaces and fuel consumption is altered correspondingly. One hundred square feet of refractory wall having an outside temperature of 600 F. will dissipate 3,200 B.T.U. per hour, the heat loss in terms of 15,000 B.T.U. coal in producer gas being equivalent to 6,000 pounds of coal per 24 hours per 1,000 sq. ft. heat surface. From the above it is evident that furnace construction, capacity of tank, shape and design of tank and appurtenances have a bearing on pounds of glass melted per pound of coal or oil.

Regenerator capacity has a direct bearing on tank fuel consumption. If regenerators or recuperators are not ample, stack temperatures increase, with the result that excessive quantities of heat are wasted up the stack instead of being used to preheat air and producer gas. So for two tanks identical in capacity, size, etc., except that one is supplied with proper regeneration, the fuel consumption of the unit with poor regenerative facilities will take 1 to 15 per cent more fuel, depending upon regenerative capacity provided.

Quite frequently fuel comparisons of tanks are made without considering the melting temperature. A temperature of 2,650 F. is attained with a certain fuel consumption while a temperature of 2,750 F. will require a much greater percentage increase in fuel consumption than the percentage increase in temperature. In Fig. 1 a typical fuel-temperature curve is shown to bring out the large fuel increases required for temperature increases at high temperatures.

The quality of coal has considerable bearing on fuel consumption and pounds of glass per pound of coal is misleading on basis of fuel quality. Even if construction details, size of tanks, regenerative capacities and melting temperature were all constant a 10 per cent or greater variation in coal consumption is possible when using high and low quality coals. Fuel oil qualities do not vary as much as coal; however, heavy low gravity oil has more heat per gallon than high gravity light oils. Fuel quality and price must be taken into consideration in making comparisons.

The effect of the above factors that make the term "pounds of glass per pound of fuel" misleading are minor when compared to the effect of tank pull. Tank pull may be defined as the percentage of full tank capacity that is drawn per day. For instance, if a tank is rated at 30 tons per 24 hours

* Mechanical Engineer, Corning Glass Works.

and only 15 tons are drawn, the tank pull is 50 per cent rated capacity. The reason that tank pull enters into the "pounds of glass per pound of fuel" is that for zero tank pull, such as over a Sunday or holiday the fuel requirements will be 85 to 90 per cent of the full load requirements during the week when operating at 100 per cent tank pull. In other words, it takes about 85 per cent of the fuel just to keep the tank

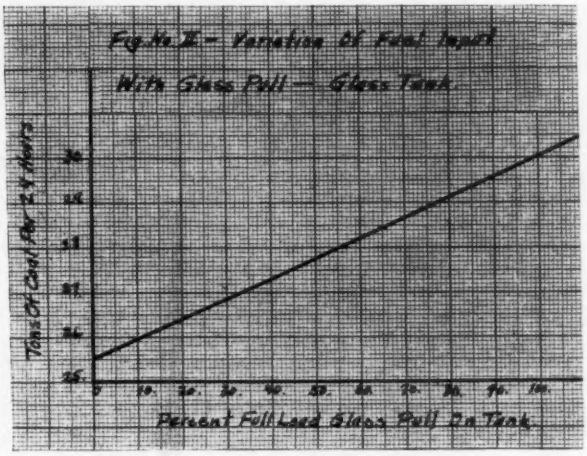


FIG. 2

hot and the other 15 per cent is used to melt the batch materials. A check on this figure may be made by observing Sunday or holiday fuel consumptions.

Take for example, a tank melting 30 tons of glass per 24

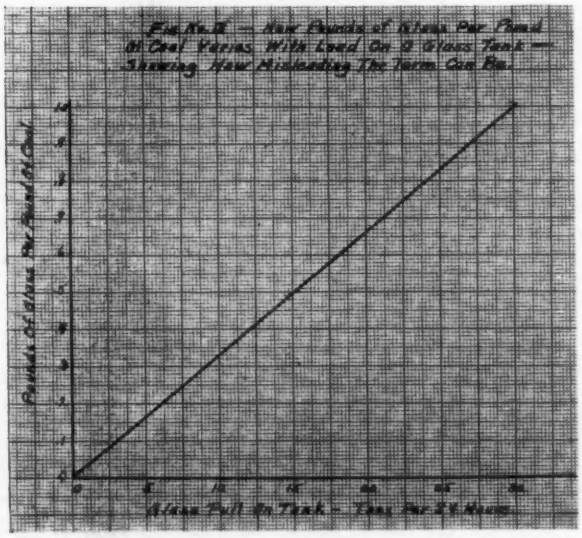


Fig. No. 3 — How Pounds of Glass Per Pound
Of Coal Varies With Load On A Glass Tank —
Showing How Misleading The Term Can Be.
Pounds Of Glass Per Pound Of Coal
Glass Pull On Tank — Tons Per 24 Hours

FIG. 3

hours with producer gas from 30 tons of coal. Then 1 pound of glass is melted by 1 pound of coal. In round figures 15 per cent of the total requirements or 4½ tons are used to melt the glass and 25½ tons are used to keep the tank up to temperature. Suppose that the tank pulled at 50 per cent tank pull or only 15 tons of glass are removed. The fuel requirements are reduced from 30 tons to 28.75 tons and the glass melted is only .522 pounds per pound of coal.

Then take for example when the tank is hot but no glass is pulled; then zero pounds glass per pound of coal is the result. Fig. 2 shows approximate curves for fuel consumption of a tank at constant temperature but with varying load. A curve, Fig. 3, is also shown to illustrate how pounds of glass per pound of coal varies with the same tank, same fuel and all conditions constant except the amount of glass drawn. A study of the curves will show "pounds of glass per pound of coal" to be misleading and that performances comparisons on this basis do not have value except when they are tied in with per cent tank pull. Unless comparisons of pounds of glass per pound of coal are made for tanks of similar construction, size, for similar fuels, under constant operating conditions as to temperature and for like per cent load conditions then results are liable to be very misleading. The simplest way to compare tank performances is to compare the rated capacity of the tank with the fuel requirements over a shut down period during which the tank is kept up to temperature. If one 30 ton capacity glass tank requires 27 tons over a Sunday with no pull then a rated capacity ratio may be developed—in the example $\frac{30}{27}$ would be the ratio of rated glass capacity to no load fuel requirements. Comparisons of this type lead to constructive effort in the correction of improper conditions and are by far more reliable than pounds of glass per pound of coal as long as a constant square foot per ton of glass figure is used for determining tank capacity.

Photo-Electric Control Equipment

Among the new developments in the electrical industry during 1930, as reported by the General Electric Company, is the use of photo-electric control equipment in the industrial field.

Photo-electric control equipment has now been developed to a point where its position in the industrial field is definitely established. It offers a means of solving some of the problems for which no satisfactory equipment has been available heretofore, and also of simplifying some of the processes now in use.

The industrial application of photo-electric equipment progressed sufficiently to warrant the establishment of a line of photo-electric devices and accessories.

Both alternating-current and direct-current photo-electric relays were applied to many problems in which the interception or application of a beam of light is used to control an electric circuit; *e.g.*, the operation of a magnetic counter, stopping and starting machines, operation of deflector mechanisms on conveyor systems, safety devices, starting or stopping operations on articles that are too small, too light, or too delicate to operate a mechanical limit switch. The ability of these control devices to operate from the interception of a beam of light offers a valuable new tool to industry.

Photo-electric tube and amplifier devices provided with terminals for connection to an indicating or recording instrument are now used in making simple comparative measurements of illumination intensities and reflecting powers, and in investigations to determine the feasibility of adapting photo-electric equipment to the solution of the more difficult problems.

The light sources for use with the photo-electric equipments are compact units employing a low-voltage concentrated-filament lamp and a plano-convex lens in such a manner as to provide an approximately parallel beam of light sufficient to operate the photo-electric relay at a distance of 25 ft.

Another new development of the General Electric Co. is de-enameling equipment for operating a process for removing the vitrous enamel from defective parts, this was perfected and placed in successful operation during the year.

The Manufacture of Rolled Plate

By ERNST LUTZ*

(*Continued from the January, 1931, issue*)

This work has been revised, so far as the English and the technical expressions are concerned, by F. W. Preston, who has also added a number of notes relating in general to the special conditions of American practice; but it must be understood that the opinions expressed in the text are those of Mr. Lutz, and neither the Editor nor Dr. Preston accepts responsibility for them.

FIG. 60 shows the interior of an old casting and annealing shop. In the middle the travelling casting table can be seen and over it the electrically operated casting crane. On both sides of the hall, and in straight rows are the annealing kilns; along each row of kilns a roller carriage moves on rails. Usually the same rails carry a number of casting tables, which are used in turn, so that between casts they may cool down again. Fig. 61 illustrates a roller carriage of older design.

FIG. 60

Casting tables, as shown, were built up to 30 feet length and 16½ feet width; the table was usually of cast iron, which for the smaller tables was originally cast in one piece, but later on, as its dimensions continuously grew, was built up in sections as shown in Fig. 59. The sections are tied together with cross rods b and c (Figs. 57 and 59).

The nuts on the protruding ends of these rods are protected with caps, as it happened that through the expansion of the table caused by the heat, these nuts burst off and injured people. Besides the cross rods, four to five wedge pieces pierce the sections crossways. These wedges are so fitted that no section can lift itself under the influence of the heat without taking the adjacent segments with it. On the other hand the wedges are free in the longitudinal direction so that the segments can expand individually. The behaviour of these tables in casting and their influence on the flatness and uniform thickness of the rough glass sheet is further discussed below. Such casting tables have proved very successful and are generally adopted. Their design and introduction is mainly due to J. Riegger, Berlin, the well-known designer and former works manager of Messrs. Zimmermann, Hanrez & Co., Monceau sur Sambre.

The development and introduction of the continuous lehr obviated the travelling of casting table and roller carriage; nowadays the roller carriage is only movable to such an extent that for repairs, etc., it can be removed out of the space between casting table and lehr. Further, as the casting table is now stationary and in contrast to older plants, only one is used, water cooling had to be resorted to.

Figs. 62 to 66 show a stationary casting table with roll and roller winch such as are in general use today. The experience gained on the old installations has been advantageously incorporated therein by Riegger. Tables of this type are now made up to 32 feet length, 18¼ feet width and a total weight of 150 tons. They consist of 9 to 11 sections resting on two cast iron supports f, which are fixed relatively to each other by two or three bars e. b, b indicate the cross rods and protection caps, which were mentioned in connection with the travelling casting tables; further six cross keys are again provided. One of the two centre cross keys is a tight fit in both directions, the longitudinal expansion of the sections therefore goes to the right and left hand side of this key. Fig. 63 shows a cross section of a key with its keyhole, and in Fig. 65 the two sections cross-batched show the keyhole g^1 in dotted lines.

Fig. 65 also illustrates how each segment is provided with six cast-in channels for the cooling water. There are three top and three bottom tubes. The three top tubes are

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* Of Desseau, Germany. This work will appear in German in the forthcoming new edition of *Dralle-Keppeler*, "Die Glasfabrikation," due this year, about July. The GLASS INDUSTRY probably will by that time have completed the English translation, with some comments on its applicability to American conditions by F. W. Preston.

FOOTNOTE: In the Figures, originally prepared for use eventually in the coming new edition in the German language of *Dralle-Keppeler*, "Die Glasfabrikation" in 1931, dimensions are given in metres (*m*) and millimetres (*mm*). We would like to have given these in feet and inches but the translation and the making of nearly two hundred and fifty new illustrations would have involved a prohibitive loss of time and expense. To some of our readers the metric system is as familiar as the English units; for the others we may say that a metre is approximately 40 inches, and a millimetre is approximately 1/25 of an inch. A thousand millimetres, of course, go to a metre.—*F. W. P.*

connected with each other and the same applies to the three bottom channels; there is however no communication between top and bottom tubes, i.e. the cooling system represented by the upper tubes is quite independent of the lower tubes. The segment at the left hand side of Fig. 65 shows the two cooling water inlets. At the right hand side are seen the cooling water outlets. Each outlet is fitted with a stop and governing valve, so that the bottom may be completely shut off and the top one kept open in case the upper parts of a segment have become hotter than the lower, and its extra dilatation tends to distort the segment. Each segment can be watched and treated separately; generally speaking, the central segments heat up more and require a more thorough cooling of their upper part than the outer segments need. To avoid any overflowing of the water from the top channels into the bottom ones, the inlets and outlets are fitted with short pieces of tubing, which at the exit side stand higher than the channels, so that the latter are always kept full of water.

When the casting table is put into commission, the correct position of the governing cocks of all segments is found by experiment and then left once and for all in this position; thus, before casting, the main water valve only has to be opened, and after casting to be shut. Depending on the cooling water temperature and the size of the table, 660 to 1,300 gallons of water are used for one rough glass sheet. If there is not a sufficient constant supply of clean water available, a circulating system must be adopted. The hot water is then pumped into a cooler or a receiver of such size that its content is not appreciably heated up by the returning warm water.

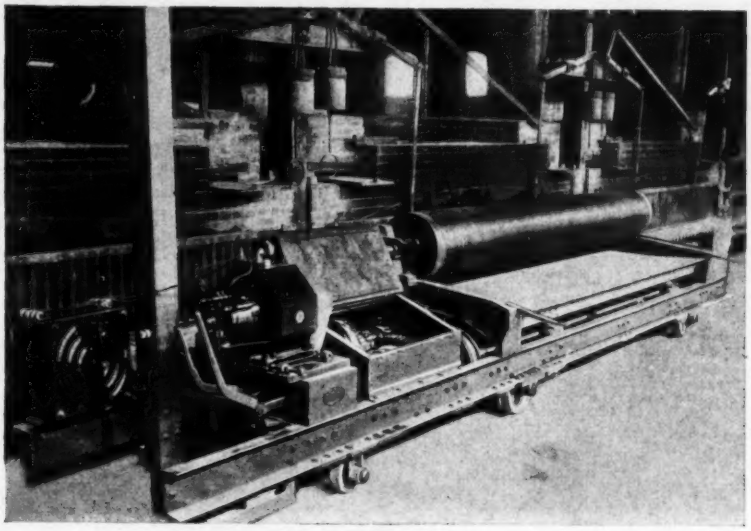


FIG. 61

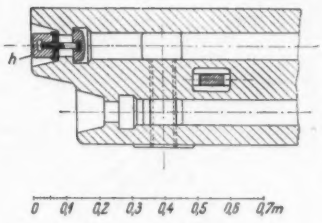


FIG. 63

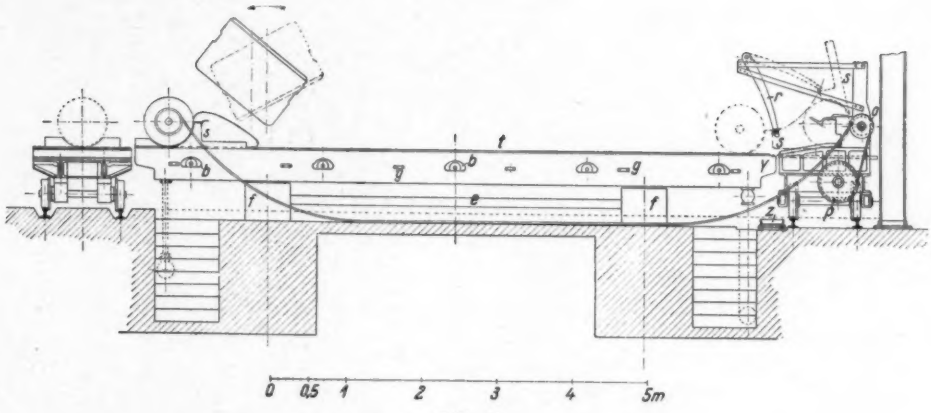


FIG. 62

All channels, as shown in Fig. 63, are sealed at both ends by means of doors h, which are fitted to the table by a "bayonet lock." For cleaning the channels of dirt and scale, the door h can easily be removed.

The roll which is equipped with an electric motor i of about 20 H.P. and the lever k allows of coupling it either with the winch for pulling the roll, or with the stowing tool. Beside the lever k is the starter l for the motor. The two motor drums for pulling the roll are marked m, m; n, n (Fig. 66) indicate the two drums on the rollershaft for which the rope pulling the roll is paid off when the roll moves towards the winch; o, o are two guide pulleys for the roll-pulling rope. The two ropes for pulling the stowing tool are fixed to the drums p, p. The slope of the first four of the threads of these drums is such that the diameter

of the first thread corresponds to only about ⅓ of the diameter of the normal thread. The insertion of the shovel therefore begins slowly and only gradually reaches the normal velocity. The velocity of the roll when rolling the glass is about 10″ per second and that of the sheet during insertion in the lehr about 60″ per sceond; further information is given below on the choice of the most satisfactory velocities.

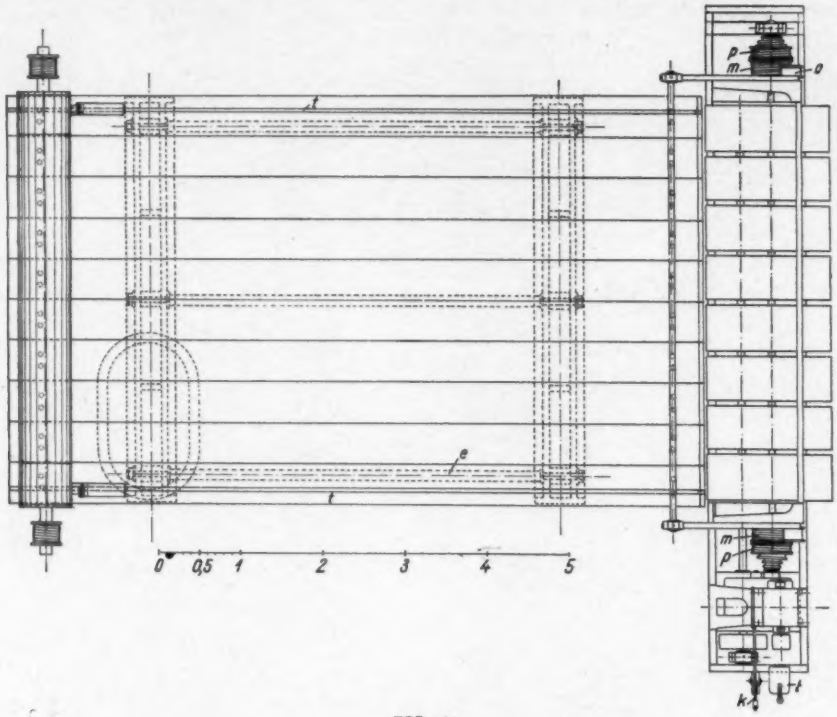


FIG. 64

The roll just mentioned, as well as that of Fig. 61, is not fitted with the special rolls shown in Figs. 57 to 59 serving for the running-up on the sloped planes of the roller carriage, but runs up on the ends of the roll itself. The triggers r catch the rollershoes or "guns" s automatically. By its movement the roll pushes these guns in front of itself; they slide on the casting table and are guided by the "trams" t, which carry the roll and fix the sheet thickness. These guns prevent the glass from overflowing sideways and thus covering the trams t.

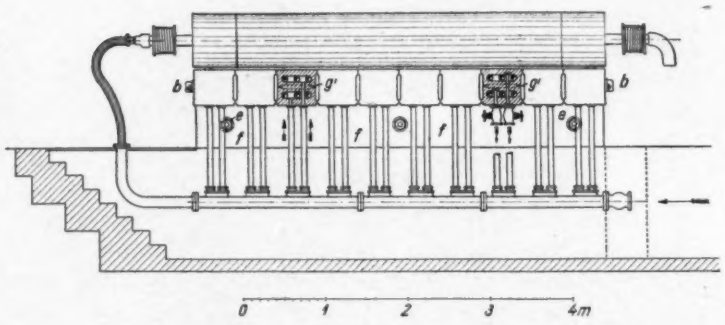


FIG. 65

Figs. 67 to 69 show an example of such a sliding shoe or gun: t indicates the cross section of one of the two trams, serving as guide to the guns. The recess u is required, because during the process of rolling one man on each side of the casting table has to follow the roll, and with a long handled hook to withdraw from the glass heap any impurities and throw them over the gun; these men with their tools also further the uniform spreading out of the glass mass so that the sheet takes the full width between the trams. If the gun should not be fitted with this recess u, but be designed as indicated by the dotted line in Fig. 67, the free inspection of the table would be difficult and the removal of faulty glass lumps be hindered somewhat.

In order to minimize the wear of casting table and roll caused by the sliding of the shoe, this latter is lined with a softer metal like copper or bronze. Sometimes, to protect the roll, the shoes are fitted with rollers w, w.; as these, however, in order to fulfill their purpose, must stand somewhat proud of the shoes, the danger arises of glass being squeezed out between shoe and roll; on account of this drawback such rollers have not been employed very often. If the glass mass is rather viscous so that the edges of the rough glass sheet cool exceptionally quick, small cracks and fissures are formed, which in the lehr may lead to the breaking of the whole sheet. Attempts have therefore been made to insulate the outer surface of the gun, i.e the one which does not come in contact with the glass, with asbestos, so that the gun should maintain the heat. An appreciable improvement, however, was not found to ensue. In some cases the surface of the gun is artificially roughened or fitted with rivetted pips x. These pips continually break

the glasskin, causing hot glass from the inner part of the heap to follow, so that the sheet edges are not rolled exclusively from the half-solid skin alone.

The succession in which the pots of a furnace are withdrawn for casting, depends mainly on the condition of the surface of the glass mass in the various pots. As mentioned before, during the period of moderate fire the surface gets dirt, stray glass and, in particular, no clay fragments of the pot, fall on the table or in the glass heap. For the cleaning of the pot bottom, strong rotating steel brushes or scrapers, driven by a motor, are sometimes used and moved across the seat.

Figs. 62 and 64 show the pot position just before casting; on the order "off" the crane is started with utmost

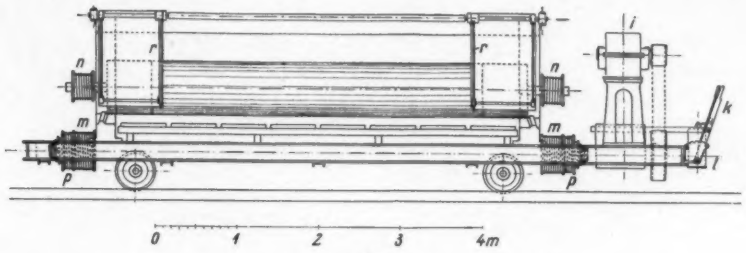


FIG. 66

too stiff, if the core of the glass mass is to have the viscosity suitable for casting. For this reason, about ten minutes before casting, the furnaces are again somewhat heated up. Now both in cooling down and heating up the pots behave differently; some have remained warmer and consequently heat up faster whilst with others the heating up takes longer.

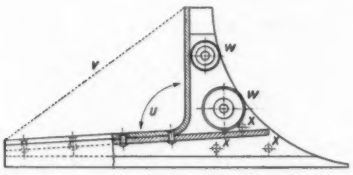


FIG. 67

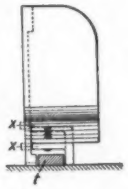


FIG. 69

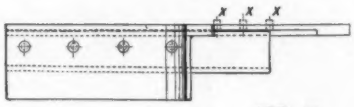
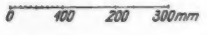


FIG. 68



The pot, the contents of which first reaches the conditions required, is first taken for casting. Depending on the pot-removing machinery it sometimes saves time if pots are taken alternately from each side of the furnace.

Figs. 70 to 72 show so-called casting scissors, as they are frequently used for the hand-pouring of the pots. These scissors consist of a rod a with two handles b and c and the two movable shanks d and e, turning on the bolts f and g of the rod a. With the aid of the two brackets h and i the shanks d and e are pressed on the pot. At k and l the rod a hangs turnable in the frame m., which itself can be fixed to and released from the casting crane n. The length of the rod a between the handles is about 36 feet. To tip the pot each handle is caught by three men, i.e. altogether six men. One of the three men at the back handle, i.e. of those who during tipping look in the travelling direction of the crane, is in command, and the 5 others and the crane operator have to follow his orders. Before the pot is brought over the casting table, its seat must be thoroughly scraped and then brushed clean; further also the pot side walls and the tong shanks have to be brushed so that no power, and the crane motor therefore must give a great starting moment. Simultaneously with the start of the crane the casting scissors are tipped. It is now essential to spread the glass mass without bubbles and strings, as uniformly as possible over the full width of the table between the two "trams."

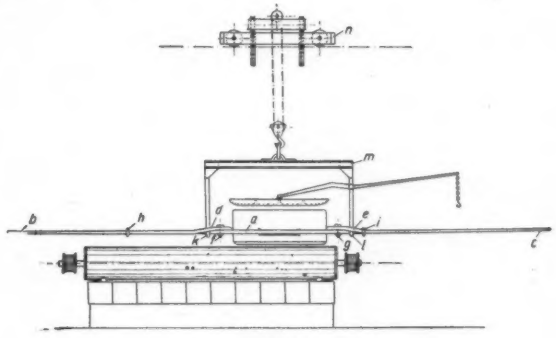


FIG. 70

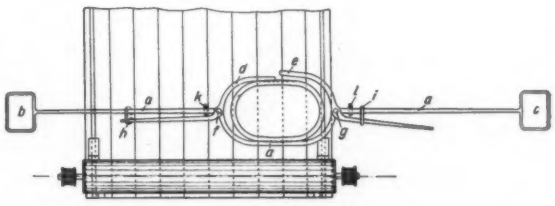


FIG. 71

The initial crane velocity, the pot-tipping velocity, the place and position where casting is started, as well as the distances of the pot to the roll and to the casting table, all these items must be properly coordinated, if the conditions of a perfect casting are to be fulfilled. It must furthermore be borne in mind that a glass mass which remained exceptionally liquid or became too stiff behaves quite differently from that of standard conditions. The glass mass must be laid as a compact heap in the corner between roll and table; at no time must the glass flow down the outer walls of the pot, but must fall freely (see Fig. 73) as otherwise, by its sticking to the outer pot wall, dirt and air bubbles are

caught and the glass gets stringy. Depending on the stiffness of the glass mass and on the velocity, the crane is capable of developing in starting, the position of the pot at the beginning of the tipping is such that it cuts the casting table or the tram. A correctly cast sheet has about the form shown in Fig. 74.

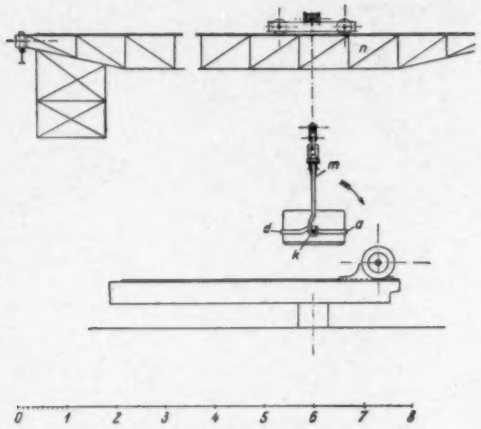


FIG. 72

If the pot is tipped too early, or if the crane starts too slowly the sheet will take the shape shown in Fig. 75. The corners x^1 and x^2 mean lost production and the surplus glass will overflow at the table end or remain in the pot i.e. fall on the floor outside the table. If on the other hand the pot is tipped too late, the glass mass will concentrate at the other end of the table and a sheet like that on Fig. 76 will result, with similar production losses. These one sided

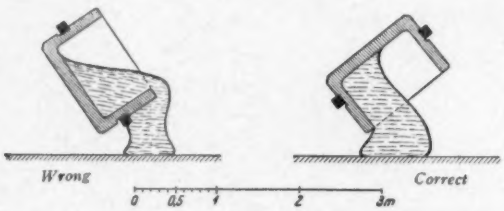


FIG. 73

cast sheets have the further disadvantage that they offer to the insertion shovel an unfavorable area of attack, and the danger arises that they get jammed, due to the eccentric action of the pushing force.

The travelling with the casting crane could be avoided if the whole content of the pot were in the middle of the casting table and before the roll. This procedure was practicable as long as the casting tables were still small; with their present day dimensions, however, a sheet as shown in Fig. 77 would be produced and appreciable waste would arise at the head corner of the sheet.

It most cases it cannot be helped that at the beginning of the tipping more glass flows out than at the end of the operations; it is then necessary to push both casting scissors and pot towards the roll. This movement is started from about the middle of the table and the pot will then describe a path as indicated in Fig. 78.

Another means, which the six men effecting the pouring have at their disposal to effect the proper distribution of the glass mass over the casting table is the retarding or speeding up of the movement of the scissors and the pot hanging on the casting crane. For all of these special movements, the man in command must give clear and definite keywords.

A number of automatic pouring devices have been designed which carry out the tipping as well as the movement of the pot according to the path shown in Fig. 78 completely automatically, so that one has only to start the motor by

FIG. 74

FIG. 75

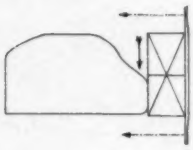


FIG. 76

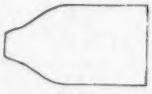


FIG. 77

means of a controller standing on the floor, and to switch it off when the pot has crossed the table. Thus the tipping is freed from manual operation. Fig. 79 shows an example of such an apparatus. The movement for the tipping can either be controlled automatically by an electric motor or by the release of a special weight. Instead of fixing the casting scissors in a rigid frame r, sometimes loose suspension with ropes and drums sitting on the scissor-shanks is resorted to. In place of turning the dead weight lever h, the pot is tipped by the turning of the rope drums. At a certain moment the pouring side of the tipping-pot acquires an excess of weight and turns over completely, so that, depending on the nature of the tipping mechanism, easily

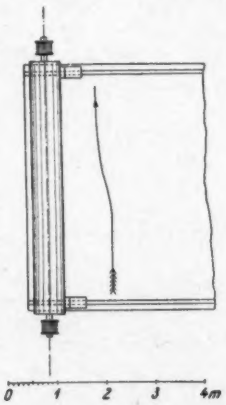


FIG. 78

adjustable brakes have to be provided to govern the last phases of the tipping. Fig. 80 shows such an automatic pouring apparatus in commission. In the U. S. A. there are similar designs in use, where the pot is tipped with the aid of an electric motor and a crank fixed on the scissor

axes. To accelerate the rate of tipping towards the end, the crankshaft which acts on the said crank is released a certain time after the beginning of the tipping by a special catching arrangement thereby speeding up the movement of the crank. These devices require only one man for the opera-

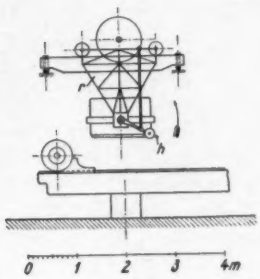


FIG. 79

tion of the crane and the pouring of the pot, and give good results.

All this machinery, generally speaking, operates reliably and, with a definite viscosity of the glass mass, can be so set that it places the glass heap in a favourable way before the roll; as soon, however, as the conditions of the glass mass deviate from those for which the apparatus is set, or

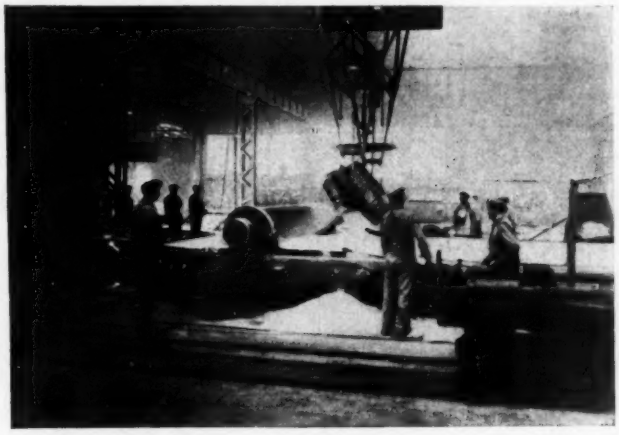


FIG. 80

if there is some small trouble in the drive, as for example a fluctuation of the voltage in the critical moments, or if the lubrication is not quite up to the normal, so that all movements require more force, which may be easily caused by the heat rising from the pot, there will at once result some more or less detrimental deviations from the desired form of the sheet, because the above mentioned corrections, as they can be applied in hand pouring, are impossible with the automatic machinery. However, in cases where there are not absolutely reliable and capable workmen at hand for the teeming, the automatic arrangement must be preferred. Even if the casting is done with a tong-crane as illustrated in Figs. 43 to 48, the application of such corrections is hardly possible; the man operating the large handwheel for tipping the pot, if required, certainly can influence the rate of tipping somewhat, but it is impossible to retard or accelerate the pot in its travel. Further it is doubtful, whether by one or more current impulses on the motor of the trolley, the pot in its movement can be made to follow the path shown in Fig. 78; both the movement of the cranebridge and the trolley are much too cumbersome to follow the necessary fine settings; if it is attempted, the danger arises of overshooting the mark and thereby spoiling the whole sheet.

It must be borne in mind that the casting table has to be crossed in one stroke, that is to say, any corrections to be applied can only be of very small magnitude, as otherwise the glass mass gets so turbulent that air bubbles are caught and strings, formed. Even at the end of the roll, on the other side of the table, the pot must not be stopped in order to pour the last residues on the table, because these remnants of glass would just drop like honey from a spoon; this part of the glass heap would be completely interspersed with bubbles, which, in rolling, would be distributed over the whole length of the sheet. As long as the pot is within the range of the casting table, the crane has therefore to move on, and the last particles of glass must be dropped on the floor if it is not possible to turn the pot so quickly back to its normal position that the said glass remains in it. The glass mass dropped on the floor is at once thrown back into the pot, so as to save its heat for the furnace.

If the whole width of the casting table between the trams is covered by the rough glass sheet, the overflow of some glass is unavoidable at the table end, as it is not possible to guess the glass quantity so accurately that the end of the table is just reached. The strips and strings of glass which are therefore hanging down at the table end must be cut off with a long handled knife, as otherwise, when the plate is inserted, they would push against the roll winch, causing dangerous cracks in the sheet. The overhanging glass would also cool at a quicker rate than the sheet end lying on the table, which again would give rise to cracks. It is advisable to provide at the end of the table the groove y (Figs. 62 and 64) of about $\frac{3}{16}$" to $\frac{3}{8}$" depth, which forms a guide for the long-handled knife mentioned before and ensures that the edge of the cut plate is fairly clean; an edge containing fissures may cause the sheets to crack in the lehr. The glass overflowing at the table end is caught in a cast iron pan (Fig. 62) which is removable, so that the glass can be returned still warm to the next pot.

(To be continued)

Simplified Practice on Abrasive Grain Sizes

The division of simplified practice of the bureau of standards recently announced that the simplified practice recommendation covering allowable limits for the sizing of aluminum oxide and silicon carbide abrasives for polishing uses and grinding wheel manufacture has been approved by the industry for publication as an effective program.

It is expected by those in the industry that the adoption of this recommendation will stimulate similar study of other kinds of abrasive grains and subsequent formulation of additional simplified practice recommendations in this field.

Dr. Arthur D. Little of Cambridge, Mass., former president of the American Chemical Society, recently was awarded the Perkins medal for the most distinguished services in the field of applied chemistry. Dr. Little, a pioneer in the application of chemistry to industry, developed many processes, including one for cellulose products largely used in the manufacture of laminated glass.

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Vol. 12 FEBRUARY, 1931 No. 2

CONTENTS

	Page
The Manufacture of Photographic Lenses	23
The Term "Pounds of Glass Per Pound of Coal" Is Misleading	28
Photo-Electric Control Equipment	29
The Manufacture of Rolled Plate (Continued)	30
Editorial:	
The Ultimate Generators	36
The Metric System	37
Liquid Immiscibility	38
Many Glass Technologists and Manufacturers Plan to Attend February Ceramic Congress at Cleveland	39
Last Year's Production of Incandescent Bulbs	40
Recent Patents	41
The Glass World and What It Is Doing:	
J. W. Cruickshand on Trip Around World	42
Libbey Glass Manufacturing Co. Doubles Capacity	42
Census of Glass, 1929	42
Southwark and Baldwin Merge	42
Kimble Glass and Vineland Flint Combined	43
Receiver for Turner Glass Corporation	43
Window Glass Prices Reduced	43
Last Year's Production of Plate Glass	43
Coming Meetings	43
What the World Wants	43
Readers' Wants and Offers	43
Current Prices of Glass Making Materials	44
Monthly Summary of U. S. Foreign Commerce in Glass	44

CLASSIFIED BUYERS' GUIDE, PAGE 20
INDEX TO ADVERTISEMENTS, PAGE 22

The Ultimate Generator:

An Engineer's Conception of Business

IF you are a busy man during the day, you are probably reading this by artificial light, which means electric light. The voltage across your lights must be kept very steady. If is gets too low, your light becomes dim. If it gets too high, your lamp burns out. In either case you suffer. To keep the voltage steady, the generators and turbines must run at constant speed, and this independently of the load. It does not matter whether half a dozen customers or half a million are on the line, the voltage has to be steady. So we put a governor on the turbines. If the turbine tries to slow down, the governor turns on more steam (or water) and speeds it up. If the turbine tries to speed up, the governor throttles the power inlet and brings the speed down again.

In order that customers may all have the proper voltage, however many crowd on to the line, we must have enough generators to take care of them all. Most of the time only a fraction of these will be on the line, and then some generators must stand idle. This cannot be helped; we recognize its inevitability and act accordingly. In the long run the public has to pay for generators that stand idle part of the time, but the price is low compared with that involved in not having enough generators to take care of the "peak" and so throwing the whole governing system and the voltage out of action.

This System Is Known as Engineering and It Is Right

If you are a business man during the day, the whole light of your life is an artificial one. You would like orders to come in steadily. If they come in too slowly you go bankrupt; if they come in too fast your organization breaks down, or else you enlarge your business so that you can go bankrupt the next time orders become slow. In either case you suffer. To keep your orders steady, the business of the whole country must run at constant speed. It does not matter whether crops are poor or superabundant, approximately the same amount of bread is needed. But we do not put a governor on our turbines; we put an ungovernor on them.

In order that people may be put to the maximum of inconvenience, we arrange that when business is good, we will encourage everybody to get on the line and wreck the generators. And when a few get off the line and we have to shut one generator down, we will shut the whole power station down with it.

This is done by not keeping the voltage, or in economic language, prices, steady. If prices begin to rise, everybody is encouraged to rush in and buy, before they rise any further. The rush to buy encourages the seller to raise prices still further; this is, in Wall Street, a "bull market," and in business, a "boom period" or period of "prosperity." The process is more or less self-propelling and the voltage rises till the generators give out; stocks rise to a Wall Street crash; inventories pile up till the futility of buying becomes apparent, and then nobody buys and there is an end to business.

This System Is Known as Modern Business, and It Is Mighty Poor

CHAPTER II

The system originates, not in human greed (which, together with human stupidity helps to maintain it) but in the vagaries of nature. The origin lies in the fact that we cannot be sure a year ahead what sort of a crop we shall have, poor or bumper. And this is true of practically all crops, wheat, corn, oranges or oysters.

We need a certain amount of bread. If a certain acreage sown with wheat would every year produce that amount of bread, then we would sow that acreage, neither more nor less, and the farmer would know that he could count on a steady and fair income. And the railroads and Great Lakes steamboats would know how much grain they had to move, and Detroit, and Chicago would know how much the farmer could buy in his turn.

But nature is not so obliging, and the crop may be poor. We thus have to sow a much larger acreage, so that we shall not starve in poor years. And when we have sown the larger acreage, we get a succession of good years, and there is no knowing where to put all the excess wheat. We could sell a fair crop at a fair price, but the excess must be sold at very much less if it is to be sold at all. And since nobody can distinguish the excess wheat from the "fair-crop" portion, it must be all sold at the lower price, and even at that it is unusable.

The system is an excellent one. It gives the grain-pit speculators a fine time. And it worries the government, beggars the farmer, and demoralizes the country.

The Engineer's solution would be, to plant an acreage which, with certain reserves in the elevators, from last year's crops, would even in the worst years suffice for the needs of the people. In any actual year there will be a surplus, perhaps very small, perhaps very large. The whole of the surplus would be impounded by the government, fed to the hogs, the wild ducks or the Chinamen, or destroyed, but would not come on the market. Nor would the government pay for it. But a reasonable crop would be left for sale at a steady price, instead of an unwieldy crop at a profitless "marginal" price.

This solution, applied to a comparatively few of those products wherein nature is fickle, but on which we depend so vitally for our essentials (wheat, corn, cotton, wool) would have a very stabilizing effect on other businesses. It would probably be very surprising to see how stable it would make the demand for iron ore and glass sand.

It is a drastic solution, demanding perhaps at times the destruction of no small fraction of the wheat crop; but it has its advantages. Nobody can starve, and business can be stabilized. This is not the place to discuss its details, the organization by which such a scheme could be made to function, the prevention of bootlegging of excess crops, and so on, any more than it is the place to discuss the mechanical design of turbines or the detailed equipment of power stations. We wish here merely to draw the analogy and to express the opinion that a solution on these lines is possible.

We wish further to express the opinion that various schemes for stabilizing the stock market, tinkering with the regulation of short-selling, of marginal purchasing, or with bank rediscount rates is about as intelligent as trying to regulate the voltage at the lamp, instead of at the turbine. We have to get back to the land, to the places where the fluctuations start, before it is any use trying to stabilize manufacturing industries or Wall Street prices. These are the final indicators, the lamps that by their misbehavior tell of ineptitude back in the open lands, the Ultimate Generators.—F. W. P.

The Metric System

A reply to F. W. P.

BY S. R. SCHOLES

Of all the evils bequeathed to humanity by Usage and Tradition, few are as time-consuming and clumsy as the English "system" of weights and measures.

We might remark, like one of Milt Gross' characters, "Is dis a system?" Must we forever spend months of time as children learning tables, and uncounted hours as grown-ups making calculations in the almost unrelated units of ounces, pounds, feet, yards, rods and acres? There is a simple way out—as simple as the adoption of decimal currency by the Hamiltonians as an escape from the pestiferous arithmetic of pounds, shillings, and pence.

The question as to the advisability of taking the decimal way out of our mensuration maze is not a technical one, it seems to me, but rather an economic one.

Let us first examine one of the arguments supporting the English system. Its natural, anatomical derivation is held up for our admiration. Logically, Dr. Preston should have begun with the "Three barley-corns make one inch" idea that used to lead off the table. This seems to be involved in arriving at shoe sizes, somehow. Perhaps the barley-grains are too small, in this year 1931 A. D. (Awful Drought.) And the twelve thumb-widths that make one foot! Think of the folk you know with long feet and slender thumbs. As a tradition, it is probable.

Equally venerable and moldy and entitled to perpetuation are the yard, the rod, the furlong; and those derived units of area and space—the pole, perch, cord, acre. But if you desire to see how nearly incommensurable these units are, try for example to compute what fraction of an acre is covered by the lot where your house stands.

If venerability is an adequate reason for preserving these ancient units, why not the Roman mile—"mille passus." Britain was once full of them, and they must have been near cousins to kilometers.

The point isn't against the units, one being as good as another; but simply that decimals are so superior to duodecimals or any other 'imals. To be sure, a nation that counts its money in £, s., and d., must be so mathematically minded that we can never hope to understand how they have time for anything else. Possibly there are in Dayton some people who can build machines for such jobs.

(Parenthetically and pathetically, we must remark here that our beloved glass industry is burdened with a similar piece of useless duodecimal arithmetic—the dozen as a sales unit. We laboriously calculate into dozens and out of dozens—to what good purpose a technologist can scarcely grasp.)

The beautiful simplicity of the meter-liter-gram system for measures and weights is well understood by everyone who has been through our common schools, and every scientific laboratory has it in daily use. Why, then, de we not make its use general and compulsory?

We cannot afford it.

So many of the tools and properties of our civilization are calibrated, established, and defined in the yard-gallon-pound system, that the prospective wastage involved in changing units is appalling. Maps, land deeds, text-books, and countless documents and papers printed and written would require revision. Millions of measuring vessels, from the housewife's kitchen to the tank-car, would be for a generation confused with the new containers. Weighing scales, commodity quotations, freight rates—all printed records and statistics based upon weights—would become obsolete or misleading. To replace all of these things would solve the unemployment problem, provided our people could find time besides for the production of the necessities of life for a year or two.

But when, if ever, America takes this extravagant step, what a fine heritage for those who come after!

A Reply

JANUARY 16, 1931.

I can only repeat, the essence of the meter system is not the fact that it is a decimal system but that it is founded on the meter and other hallucinations. Decimals (dividing things into tens) are themselves contrary to human nature, which insists (even in "metric" countries) in dividing things by two. You buy a ¼ kilogram, not 2 hectagrams. But decimals have their uses, and a decimalized inch is perfectly sound.

The U. S. currency is not metric, but decimal. Fortunately it did not occur to its founders to make the dollar the value of a cubic centimeter of cold water. F. W. P.

Liquid Immiscibility

DR. LOUIS NAVIAS was born at Grodno in Russia in 1897; we presume that this is the Grodno in modern Lithuania, and that his early proximity to Germany constituted a serious threat to his education. But with exquisite taste or good fortune, or both, Dr. Navias chose to be educated in South Africa, at King Edward the Seventh School, where he matriculated in 1913. We may, therefore, claim him as one of the truly elite.

DR. LOUIS NAVIAS

Moving to the United States, he took his first degree, B.Sc., in chemistry at the College of the City of New York, in February, 1918. His post-graduate studies were at the University of Illinois, his course, like that of empire, being continually westward. Here he received an M.Sc. in Ceramic Chemistry in June, 1921, and a Ph.D. in the same subject in February, 1923.

He was a Fellow in Ceramic Chemistry of the University of Illinois from 1920 to 1922, is a member of several American scientific societies, and has been an active member of Sigma Xi since 1921.

From 1918 to 1920 he acted as Chemist in the Optical Glass Plant of the Bausch & Lomb Optical Company, and in 1923 served as Ceramic Expert on the U. S. Tariff Commission. Since 1924 he has been Ceramic Chemist in the Research Laboratories of the General Electric Company. From time to time he has published papers on his favorite themes, largely in the Journal of the American Ceramic Society.

ON December 18, Dr. Louis Navias of the General Electric Company, Schenectady, gave a lecture to the Pittsburgh sections of the American Ceramic and Chemical Societies at the Bureau of Mines Building, Pittsburgh, Pa., on "Liquid Immiscibility as Exemplified by Borate and Silicate Melts." The meeting was well attended by the ceramists and glass men, but the chemists apparently thought it would be too deep for them and did not show up in their usual numbers.

The lecture was illustrated by an excellent series of lantern slides, by an experiment on the lecture table and by numerous specimens of queer glasses in which the immiscible conditions had persisted to room temperature.

There are many pairs of liquids that will mix completely in certain proportions and will not mix in other proportions, at least over a certain range of temperatures. The lecturer showed an experiment with the two liquids, glycerol and guaiacol. At room temperatures these mix completely in all proportions. If either one is present in large excess compared with the other, the mixture stays mixed at all temperatures. But if the substances are present in comparable proportions, then on warming a little, the liquid separates into two "phases." These two phases are both liquids and they are not the original liquids, but one phase contains a little more glycerol than the other, and the proportion varies as the temperature rises.

When the temperature gets high enough, however, the two liquids begin to approximate to one another again, and finally the mixture clears up and becomes a single liquid once more.

In a great many glasses the same thing happens, but here the lower part of the history (i.e., what happens at low temperatures) is complicated by the fact that the glass becomes solid, or throws out crystals, or both, so that it is only above a rather high temperature that two liquids can be distinguished.

On the whole, borate glasses and silica glasses behave much alike; those oxides that mix in all proportions with silica are apt also, in general, to mix in all proportions with boric acid (B_2O_3). Such oxides are, notably, soda, potash and alumina. Those that in some proportions or other are apt to form two liquids are such oxides as lime, strontium oxide and magnesia. Barium oxide hovers between the two and apparently some uncertainty exists as to its exact status.

Iron oxide (FeO) in the ferrous condition is miscible, but the ferric oxide is so unstable that its behavior is not yet known.

Many of the coloring oxides, such as cobalt, are apt to form two liquids and of course the combinations of two liquids produces a turbid glass, droplets of one liquid being dispersed through the other. This condition can often be frozen in and obtained at room temperature. Samples of blue cobalt glass and white magnesium glass (20% MgO. 80% B_2O_3) showing this turbid condition were exhibited and samples were also provided to show that a comparatively small change in the percentage of cobalt (say) would result in a single liquid and a perfectly clear glass. For it must be understood that in all cases the immiscibility, or formation of two liquids, in the melt, takes place only for certain proportions of the two oxides. In the case of barium, the range in which it is immiscible is quite short, while in the case of the alkaline earths, other than barium (say magnesium or lime), the range of immiscible mixture is quite long. Dr. Navias was careful to say that he was not discussing his own original researches but merely bringing together a great many scattered observations, but the lecture was very well received and regarded as one of the most important of the season and of a highly satisfactory nature.

Many Glass Technologists and Manufacturers Plan to Attend February Ceramic Congress at Cleveland

New Division of Materials and Equipment to Be Organized

MANY subjects of decided importance to the glass, refractory, art and other divisions of the American Ceramic Society will be up for both formal and informal discussion at the annual meeting of the American Ceramic Society to be held at Cleveland, O., during the week of February 22 to 27 inclusive, together with four other ceramic associations representing the refractories, brick, grinding wheel and feldspar grinders' industries. The separate meetings of the seven divisions of the American Ceramic Society as well as all the other associations will be held in the Auditorium conveniently located in the downtown section of Cleveland. Local Cleveland committees are said to have a wonderful entertainment planned.

An exposition of ceramic products, materials and equipment will open in the Cleveland Auditorium on Sunday, February 22. At the Hotel Cleveland the trustees, directors and the Societies committees will meet. The president's reception will be held at the same hotel 3:30 P. M. The American Ceramic Fellows will meet Sunday evening at 8 P. M. with General Orton, Jr., as chairman and also on Monday, February 23 at 9:30 A. M.

Society to Add to Organization a New Materials and Equipment Group

During the meeting important action will be taken when there will be inaugurated a new division known as the Material and Equipment Group.

Work on this has been under way for many months and great progress has been accomplished according to reports from the committee of men endeavoring to create the interest needed. The business houses handling material and equipment have been acquainted with the plan and responses are very favorable.

Every man representing firms producing material and equipment should be in attendance at the Hollenden Hotel, *Sunday, February 22nd, immediately after luncheon for a brief organization meeting and also at the banquet, Monday, February 23rd, 7 o'clock, at the Hollenden Hotel.*

Members are requested to register immediately upon arrival at Cleveland at the Society Headquarters in the Cleveland Auditorium.

The Glass Division's headquarters will be in the Hotel Hollenden, the Art Division at the Hotel Statler, and the Refractories at the Hotel Cleveland. On Tuesday, February 24, the Glass Division technical meetings with the reading of papers will begin. The program will start at 9:30 A. M. and continue till 1:30 P. M., leaving the rest of the afternoon free to members for personal diversions. On the same day the Division dinners will be held at 6:30 P. M. at the respective division headquarters. On Wednesday, Thursday and Friday the meetings will be continued between 9:30 A. M. and 1:30 P. M. The exhibition of ceramics will be open daily 1 to 10 P. M.

The Feldspar Grinders' Institute meeting and luncheon will be held on Thursday, February 26, at 7 P. M. at the Hotel Hollenden. On Friday a meeting of the Chicago World Fair's Ceramic Association will be held at 9:30 A. M. to 12:30 P. M. and 2 P. M. to 6 P. M. at Hotel Statler.

One and one-half round trip fare on certificate plan has been granted by all railroad passenger associations.

Additional Division Papers

In addition to the papers listed in the January issue there will be one on Glasses Suitable for Industrial Eye Protection by E. L. Hettinger, Willson Products, Inc., Reading, Pa. Among the numerous papers offered by the Refractories Division is one on the Insulation of Glass Tank Regenerators by R. M. Langley, Johns Manville Corporation, also Chromium Plating in the Ceramic Industry, Henry C. Wolfe, United States Chromium Corporation, Pittsburgh, and Some Problems Encountered in the Manufacture of Refractories from Fused Alumina by J. S. Masen, Federal Abrasives Company, Anniston, Alabama, and G. N. McVay, University of Alabama.

Don't Miss the Glass Division Movies

Dear Editor:

Preston was down at the house last night with a roll of Cove Point film, the best you ever saw. I am predicting that we have people who will want to borrow them to take a second look at them. Too bad you can't take out a bunch of scenes from these and print them.

Yours very truly,
(Signed) F. C. FLINT.
Hazel-Atlas Glass Company.

Washington, Pa., January 15, 1931.

Glass and Ceramics at 1933 World's Fair

One of the subjects which will be widely discussed at meetings and among members personally is the coming Chicago Centennial Ceramic Exposition. On January 8, a meeting was held at the Stevens Hotel, Chicago, under the auspices of Professor Edward Orton, Jr., president of the American Ceramic Society. Attention was called to the fact that this centennial exposition is a vitally important matter inasmuch as it affects the position the ceramic industry will have in comparison with the exhibits of producers of non-ceramic products.

Decided progress has been made in organizing this 1933 Centennial celebration. The transportation and executive buildings are erected. Nearly all of the industrial groups have very carefully worked out plans for showing their scientific developments and contributions to science and industry during the past century. Some of these groups have raised sums of money ranging up to $500,000.

The ceramic groups must be at this exposition with exhibits showing the past century of developments and contributions to art, science, and technology in clay, glass, and porcelain enamels.

The scheme is to have a central general ceramic exhibit contributed to by industrial firms of products, equipment, materials and operating processes.

(*Continued on page* 40)

Last Year's Production of Incandescent Lamp Bulbs

The article "Our Great and Growing Glass Bulb Industry," published a year ago in the January, 1930, issue and showing the enormous increase that had taken place during 1929 in the sales of glass bulbs for incandescent electric lights, created widespread interest, and we are pleased to be able to present herewith similar statistics covering the year 1930. These figures were compiled on the same basis as those of the 1929 production and the 1930 production may therefore be compared directly with the figures given for 1929. This information has been furnished through the courtesy of A. H. Stricker, manager, Statistical Department, Incandescent Lamp Department, General Electric Company, Nela Park, Cleveland, Ohio.

It will be noted that production in 1930 of all the classifications of lamps showed a decrease averaging 17%. Considering the unsettled state of business during 1929 it seems that the bulb-making industry has held its own during the prevailing depression more successfully than some of the other branches of the glass industry.

1930 PRODUCTION OF GLASS BULBS FOR INCANDESCENT ELECTRIC LAMPS

	Quantity in Millions	% Increase 1930 over 1929
(a) For use in the manufacture of what is termed "Large Lamps" comprising all such which are not included in the group below	320	1.4 (decrease)
(b) For what is described as "Miniature Lamps," including Flashlight, Automobile, Christmas Tree and Miscellaneous	247	25.0 (decrease)
(c) For Vacuum Tubes	64	39.0 "
Total	631	17.0 "

Toward the close of last year a preliminary estimate of the number of incandescent lamps sold in the United States during 1930 and reviewed by John Liston in the General Electric review for January indicated a total of approximately 564,000,000 lamps both large and miniature. An innovation put into effect during the year, Mr. Liston stated, was the addition to the line of inside frosted lamps of the 150, 200, 300 and 500-watt sizes which had previously utilized clear glass. Another development of the year was a pre-focused spot lamp for theatre spotlight service which overcomes the difficulties heretofore experienced in focusing these lamps and permits an accurate adjustment of the spotlight mirror at the factory with the lamp in a definitely fixed position.

The photoflash lamp, a new development in the field of photography, incorporates a radically new principle in lamp making. It consists of a bulb and base, similar to the familiar 100-watt lamp, but differs from this lamp in that instead of having the usual coiled filament it consists of several sheets of extremely thin aluminum foil in an atmosphere of pure oxygen. A tiny 1.5-volt filament, coated with a special getter, accelerates the start of the flash. The lamp will operate equally well on any voltage from 1.5 to 125 volts. The duration of the flash is about 1/50th of a second, sufficiently fast to stop the usual movements of people. A single lamp provides ample light for photographing individuals and small groups. More lamps in suitable reflectors are required for larger assemblies.

(*Continued from page* 39)

Surrounding this general exhibit, booth spaces will be sold by the Exposition management for firm advertisements by suitable private exhibit.

The task of the American Ceramic Society is to provide the central general exhibit. This is a large task.

The January 8 meeting was an enthusiastic one. Among the many ceramic men present was John J. Baushka, Chicago representative of the Morgantown Glass Works, the Imperial Glass Company and Newton's Rock Crystal; and George Dougherty, Morgantown Glass Works, Morgantown, W. Va.

The Chicago Century of Progress exhibition is already making fast headway. The administration building is already finished and occupied. The transportation building is practically finished. Good progress has been made on other contracts. The site is on park land located immediately adjacent to the central business section of Chicago, 700 acres approximately along the lake front south from where the Field Museum, the Aquarium, and Planetarium and Soldier Field are located. These institutions will be essentially a part of the attractive features of the exposition. The Field Museum last year was visited by 1,600,000 people. The Aquarium is probably the best in the world. The Soldier Field stadium has permanent sitting arrangements for over 100,000 people. One of the automobile companies has indicated that it wishes to put on an assembly plant so that a man may arrive at the exposition, order his car, watch it made, get into it when it is finished and drive it home. Maybe it will; and then, again—.

Special Buildings for Ceramics

At the January 8 meeting President Orton requested Secretary Purdy to state his views as to the situation concerning the Century of Progress exhibition. In the course of his address Mr. Purdy said: "We have to set up a central exhibit showing the development in ceramics during the past century, and the influence of ceramics on science and civilization. Other industries, our competitors, are going to be there with such exhibits. They are going to demonstrate to the world that their particular indusry has been an essential factor in the creation of civilization and in making people happy and prosperous. Ceramics must be there, and must be there collectively. We must show what the silicate industries have done to promote civilization.

"If the vitrified sewer pipe has not done a whole lot for man's happiness and welfare, then I don't know what sewer pipe is. And the same way with brick, and the same way with all sorts of glass articles, the entire list of them, from spectacles to microscopic and telescopic lenses, down to our window panes, and beer bottles. The same with pottery of all sorts, sanitary, industrial and household.

"We must place our ceramic industries to the fore. We cannot do it if we are disintegrated, we must do it collectively. Simply because spectacle lens, a brick, a bath tub, or a piece of enamelware is very distinct in character and in final shape and in use does not alter the fact that they are basically one and the same thing, they are silicate compounds created into useful things by firing.

Col. James F. Bell, in charge of Applied Science and Industrial Art Exhibits for the 1933 Exhibition, spoke about having things in motion. He stated that at the exhibition there would be a glass tank in operation. If possible the evolution of the glass industry from its beginning will be shown. Ross C. Purdy called attention to the fact that it is proposed that in connection with the Century of Progress exposition an International Ceramic Congress will be called. President Orton suggested that delegates should be appointed to attend a meeting to be held in Berlin, Germany, May, 1931, at which delegates from the various ceramic societies and associations of Europe will gather and presumably would form an international society. It should be arranged that delegates from this country attend the Berlin meeting and extend the proper invitation so that in 1933 there would be the possibility of having this event scheduled and all nations plan to have their ceramic delegates some to this country at that time.

Edward Orton, Jr., president, American Ceramic Socety, in a letter to the members states: "We must not fail to have ceramics in the Chicago Centennial Fair in a big way. It means business." Foreign ceramics will be in foreign country buildings.

Candidates for Office, American Ceramic Society

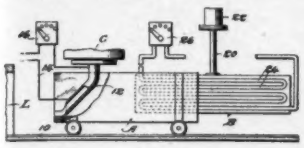
The following candidates have been placed in nomination by the committees, in due form, for the year 1931-1932: For President, E. V. Eskesen; Vice-Pres., Alexander Silverman; Treasurer, H. B. Henderson. For members of the Board of Trustees, to serve three years; Charles L. Sebring, Art Division; Emerson P. Poste, Enameling Division; J. M. McKinley, Refractories.

Recent Patents

NEW INVENTIONS DESIGNED TO IMPROVE GLASS AND THE MEANS OF PRODUCING IT

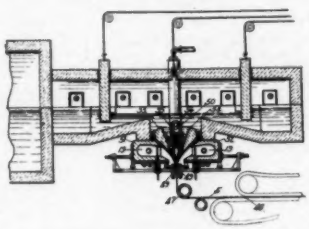
Complete copies of U. S. Patent Specifications may be obtained from the Commissioner of Patents, Washington, D. C., Price 10c each

METHOD AND MEANS FOR FORMING GLASS ARTICLES. U. S. 1,787,460. Jan. 6, 1931. Albert C. Wilcox of Bridgeport, O. Filed 8/16/29. According to this invention, it is proposed to form glass articles either by joining together in a novel manner separate pieces of glass previously formed to desired size and shape, or by bending a single piece of glass into desired shape and adding glass thereto to produce the article desired. The glass article supporting and moving means A consists, in this instance of a wheeled car mounted on track rails 10 for travel beneath the source of molten glass C, while the latter consists of a molten glass container having a downwardly directed molten glass discharge spout or nozzle 12.

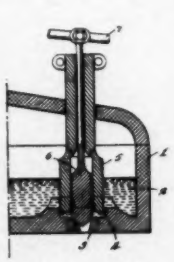


Two or more pieces of glass may be placed in the car A in a desired relation in which they are to be joined together, and heated to render them sufficiently viscid at least adjacent to their edge or other portions to be joined together, so that if molten glass is deposited on their heated, viscid portions, it will unite therewith and form a homogeneous joint or connection.

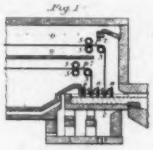
METHOD AND APPARATUS FOR DRAWING SHEET GLASS. U. S. 1,781,452. Nov. 11, 1930. Enoch T. Ferngren, Toledo, O., assignor to Libbey-Owens-Ford Glass Company, Toledo, O. Filed 3/20/22. By means of a cooling element within the mass of molten glass above the discharge point a source of cooler stiffer glass is created, and at the same time this cooling means acts as a line of resistance to the drawing force, and the sheet will, to a certain degree, be hung or supported from this cooling device. The glass affected by the cooling means which is to form the central or major portion of the sheet, is separated from the more fluid glass which is to form the surface portions of the sheet by refractory partition members which are arranged to separate the cooler glass from the hotter, more fluid glass, and at the same time guide the three streams of glass to a common line of discharge, where they coalesce to form the single sheet of glass which is drawn vertically downward until partially set in sheet form. In this way the tension or pulling strain is confined largely to the interior portion of the sheet, leaving the surface portions to flow freely from contact with the container, thus eliminating the lines which would ordinarily be caused by the cooler surface glass adhering to the edges of the outlet orifice in the container.

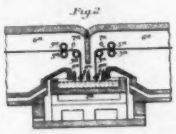


APPARATUS FOR SERVING GLASS. U. S. 1,776,538. Sept. 23, 1930. Homer Brooke, Mount Vernon, N. Y. Filed 1/25/27. In combination with a receptacle for molten glass having an opening in the bottom thereof, a sleeve located above the opening and extending into the glass within the receptacle, a plunger fitting neatly within said sleeve, means for moving said sleeve and plunger away from the opening to accumulate a charge of molten glass and toward the opening to segregate the charge, and for further moving said plunger independently of said sleeve toward the opening to extrude the charge and cut off the flow of glass from the opening.



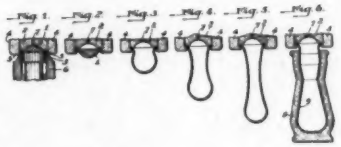
METHOD AND APPARATUS FOR THE MANUFACTURE OF SHEET GLASS. U. S. 1,786,892. Dec. 30, 1930. Clarence P. Byrnes of Sewickley, Pa., assignor to Window Glass Machine Co., Pittsburgh, Pa. Original application filed 3/2/20. Divided and this application filed 7/5/24. Heretofore, each tank has been provided with one drawing extension or drawing tank, and one continuous sheet has been drawn therefrom, but by drawing sheets in different directions or stepping them vertically, one over the other, a plurality of sheets may be drawn from the same general bath system.





The inventor in an apparatus for simultaneously producing a plurality of sheets of glass, a horizontal lehr, a series of conveyors for carrying the separate sheets in parallel horizontal planes through the lehr, and means positioned between each pair of conveyors for protecting the lower sheets from falling material.

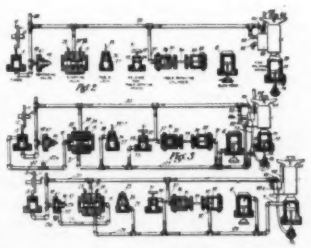
METHOD OF FORMING THIN-WALLED GLASS ARTICLES. U. S. 1,785,535. Dec. 16, 1930. Theodore H. Sloan, Charleroi, Pa., assignor to Macbeth-Evans Glass Company. Filed 9/28/29.



The invention is predicated upon the discovery that by pressing on the lower end of a vertically disposed blow head a blank or parison of a particular shape, the blank may be developed and blown while the blow head is maintained in its vertically disposed position and while the blank is laterally unconfined and is unsupported from below.

Fig. 1 is a vertical central sectional view through the lower end of the blow head and the upper end of a pressing plunger, while the two are cooperating to form a pressed blank; Fig. 2 a similar view of the lower end of the blow head after the blank has sagged downwardly through its chilled flange; Figs. 3, 4 and 5 views similar to Fig. 2 illustrating successive stages of the further development and downward elongation of the blank; and Fig. 6 a vertical central sectional view through the lower end of the blow head and a mold with a blown lamp bulb in the mold.

METHOD AND APPARATUS FOR FORMING GLASS ARTICLES. U. S. 1,775,964. Sept. 16, 1930. David L. Middendorf, Columbus, O., assignor to The Federal Glass Company, Columbus, O. Filed 8/4/25. An object is the provision of an apparatus for forming articles of glassware, whereby all of the surfaces of the article may be polished, and crinkles and roughness removed therefrom, also to provide for automatically fire polishing the interior surfaces of articles of glassware, whereby such surfaces are given a high brilliance and luster, also the provision of means whereby articles of glassware, which are formed by being pressed and then finally shaped, are initially expanded before being finally shaped, also means whereby articles of pressed, or pressed and blown glassware, may be fire-polished while such articles remain in the pressing and blowing machine. Figure 3 is a diagrammatic view, showing the system of pipes conducting air under pressure, and the parts to which such air is conducted, and also showing one system of pipes which conducts air under pressure intermittently, and the parts to which such intermittent air is conducted.



The Glass World and What It Is Doing

News of the Industry

J. W. Cruikshank on Trip Around World

J. W. Cruikshank, who two years ago retired from business as a consulting engineer to the plate glass industry in Pittsburgh, and returned to his family estate of Langley Park, Montrose, Scotland, has been on a brief visit to his old stamping grounds of Western Pennsylvania.

J. W. CRUIKSHANK

He was on his way to the west coast, whence he is about to take a trip around the world. His first stop will be at Tahiti, in the South Seas, and from there he proceeds to New Zealand. He will give this beautiful land a few weeks of his time, and will also cruise out thence on a trip of several thousand miles to the islands of the Samoa and Fiji groups. Returning to New Zealand, he will take a boat to Sydney, New South Wales, Australia, 1,500 miles across the Tasman Sea. At present his plans call for a journey thence north along the Pacific Coast of Australia to New Guinea, Java, and Singapore. His route after that lies probably through India and the Mediterranean.

Since his retirement, and indeed before, Mr. Cruikshank has been greatly interested in photography, and he is taking with him a great battery of movie cameras and still-picture making equipment, including material for making colored pictures. We are putting in an advance order for a copy of his pictures of the South Sea Islands.

His Scottish estate is a little more than a thousand miles north of his old Pittsburgh headquarters, and the vegetation is about twice as luxuriant. He showed us pictures of both the house and the gardens.

We wish him a very pleasant and useful trip, and expect great things from his photographic efforts.

Libbey Glass Manufacturing Company Doubles Capacity

A one hundred per cent increase of plant capacity is expected to result from the expansion program started January 2 at the plant of The Libbey Glass Manufacturing Company at Ash Street and W.&L.E.R.R., Toledo, O. A large increase in the company's orders for glass tumblers has made it necessary to prepare for a higher rate of production, according to officials of the company.

The equipment layout and the design for the buildings has been prepared by The H. K. Ferguson Company, Cleveland, O. This work was in charge of C. H. Van Tine, formerly president of The Devore Engineering Company of Toledo, now merged with the Cleveland firm of engineers and builders. The contract for the construction has also been awarded to the Ferguson organization, with orders to proceed at once with the initial phase of the program.

The present work will include buildings required to house three new blowing machines, three furnaces, lehrs and other equipment necessary for an output of 40,000,000 tumblers per year. Modern mechanical equipment for handling both incoming materials and the finished product is to be installed. In addition to the manufacturing buildings there will be a new warehouse, engine room, machine shop, boiler house, producer house and batch mixer building. The total area of new floor space will be approximately 100,000 square feet, costing with equipment about $600,000. Production is scheduled to start in the new plant March 15th.

In general the buildings will be of conventional type, with structural steel frame, brick walls, steel sash, composition or corrugated asbestos roofing and concrete or wood block flooring. All power equipment is to be designed and installed by the engineers. A battery of silos for the storage of materials is to be built in connection with the mixing equipment. When completed the Libbey plant is expected to be one of the most modern and efficient units in the industry. Two hundred fifty tons of structural steel will be required.

Census of Glass and Glassware, 1929

A preliminary tabulation of data collected in the census of manufactures taken in 1930 of value for the year 1929 shows an increase of 2.8% over the production reported in 1927. The total for 1929 amounted to $283,921,102 as compared with $276,128,839 reported for 1927. The total for 1929 is made up as follows:

Polished plate glass, 146,314,469 sq. ft., valued at $49,774,248; window glass, 401,760,711 sq. ft., $25,914,272; wire glass, 42,816,480 sq. ft., $5,989,885; tableware and ovenware, $16,862,223; stem pressed tumblers and goblets, 22,216,007 dozens, $7,083,382; blown tumblers, stem ware, and bar goods, $7,637,431; shades, globes, and other gas and electric goods (except electric bulbs), $9,438,762; milk bottles, 2,609,547 gross, $11,946,940; narrow-neck blown bottles (packers' ware), 2,584,378 gross, $9,229,116; wide-mouth blown bottles and jars (packers' ware), 5,872,129 gross, $22,733,512; fruit jars (home-pack), 1,127,053 gross, $8,264,325; beverage containers, 3,828,042 gross, $16,704,361; medicinal and toilet preparation containers, 12,539,466 gross, $32,672,316; general purpose containers, 4,289,138 dozens, $5,590,515.

In 1929 the number of establishments in this industry showed a decrease of 0.7 per cent, dropping from 269 to 267. The number of wage earners, not including salaried employes, employed was 71,416, and the wages paid amounted to $89,854,805, which represented increases of 8.5 per cent and 10.6 per cent, respectively, over 65,825 wage earners and $81,352,734 in wages, reported for 1927.

The cost of materials, containers, for products, fuel and purchased electric current in 1929 was $106,470,665 compared with the 1927 total, $109,911,464. The 1929 figures do not, however, include the cost of mill or shop supplies while the report of 1927 did include them. In addition to glass and glassware, glass factories produced other products to the value of $5,353,400. The value added to the cost of materials by manufacturing process totalled in 1929, $182,803,837. The figures given above are preliminary and subject to revision.

Southwark and Baldwin Merge

The Southwark Foundry and Machine Company, Philadelphia, Pa., on December 31, has transferred the major portion of its assets to the Baldwin-Southwark Corporation. The latter corporation has assumed all outstanding liabilities and will carry on the entire business formerly done in the name of the Southwark Foundry and Machine Company. All communications concerning the latter company should be addressed to the new concern at Paschall Station P. O., Philadelphia, Pa. The new company maintains offices also at Akron, O., and Chicago, Ill.

The affiliation of the two organizations brings together two of the oldest industries engaged in manufacturing hydraulic machinery, power tools, testing equipment and special machinery. In their new location at Eddystone, Pa., the company possesses greatly increased facilities for the design and manufacture of mechanical equipment. There will be no change in the Southwark management, sales or engineering personnel.

Among the company's hydraulic machinery products are presses now being used quite extensively for the manufacture of laminated glass.

Kimble Glass and Vineland Flint Combined

The Kimble Glass Company of Vineland, N. J., and the Vineland Flint Glass Company on January 16th announced that a merger of the two companies had been completed to be known as the Kimble Glass Company. The merger was effected mainly through the efforts of Evan E. Kimble, president of the Kimble Glass Company, and Victor Durand, proprietor of the Vineland Flint Glass Company. Mr. Kimble will continue as president of the company. Mr. Durand will be vice-president and Herman E. Kimble will continue as vice-president and general manager of the combined companies. The executive and operating staffs of both concerns will be merged and few changes in the organization will be made. It is the intention of those interested to use all available resources, both of man power and machinery, with the purpose of bringing about greater economies in operation and increasing the scope of the business.

Receiver for Turner Glass Corporation

Late in December Engene Iglehart of the Fletcher-American National Bank of Indianapolis was appointed receiver for the Turner Glass Corporation of Terra Haute, Ind. The company operated plants at Terre Haute and Winchester, Ind., and had been interested in a plant at Fairmont, W. Va. It has been a large manufacturer of a general line of glass containers, toilet and medicine bottles, etc. According to a report in a Terre Haute newspaper, the proceedings are said to have been of a friendly nature and designed to relieve the company from a situation caused by taking large contracts in the face of strong competition for glass products at a price so low that it could not show a profit.

Window Glass Prices Reduced

An increase in wages was arranged at Toledo the latter part of December between Glen W. McCabe, president of the Window Glass Cutters' League, and George Pope MacNichol, Jr., of the Libbey-Owens-Ford Glass Company, and simultaneously the announcement was made that window glass prices had been reduced 20%, bringing the cost near to the lowest point reached in many years. The new scale for glass cutters is 35 cents a box for single strength and 50 cents for double strength, the old scale was $.50 for both thicknesses. It was intimated that no further cuts in the price of window glass would be made.

Good Reasons for Being Optimistic

The Miller Machine and Mold Works, Columbus, Ohio, reported through A. G. Doll that the year 1930 had been the most successful during their entire career. A continuation of the company's prosperity during 1931 is anticipated.

A. G. Doll, associated with Mr. Miller in the company, gave THE GLASS INDUSTRY office a pleasant surprise on January 24 by letting it be known that he, Mr. Miller and their party who recently made a tour of Cuba and the West Indies, were in New York on their way home. They reported an exceedingly pleasant trip including some pleasant surprises such as finding Federal and Hocking glass company tableware in use 'way back in the mountains of Haiti. We hope to persuade Mr. Doll to give us full particulars of the trip after he gets home and rested up a bit.

Last Year's Production of Polished Plate Glass

The production of polished plate glass in the United States for the month of December, 1930, was 4,941,405 sq. ft., which brings the total production for the year 1930 to 105,824,074 sq. ft.

These are the authoritative figures compiled by P. A. Hughes of the Plate Glass Manufacturers Association. They tell of a decrease of 44,674,213 square feet from the total production in 1929. Apparently the plate glass manufacturing industry operated during the past year at about 67% of its 1929 record.

Trade Activities

Fostoria Glass Company directors at Moundville, W. Va., in December declared a dividend of 2%, making the year's total earnings 11%.

The Texas Glass Company, Santa Anna, Texas, is reported incorporated, with a capital of $100,000, by F. R. Hoppe and C. P. Zenor, Jr.

Grand River Glass Company, Inc., 1068 Cloverdale Street, Detroit, Michigan, has been incorporated to deal in and install glass and glass products, by Max Spiegelman and others.

American Crystal, Inc., Waterbury, Conn., formerly known as the American Crystal Company, was reorganized on October 22, 1930, to manufacture beveled glass circles, plain circles, and to do bending and make mirrors.

The Nold Paint and Glass Company, Louisville, Ky., has been chartered with a capital of $30,000 by Eva Nold, Catherine M. Smith, Mrs. A. Smith, J. B. Nichols, A. B. Bicknell, M. J. Streicher and C. P. Smith.

The DeLuxe Glass Company, Inc., has obtained articles of incorporation in Indiana "to manufacture and sell plate glass and mirrors." Incorporators were listed as Ruth Nienaber, 715 Willow Road; Paul W. Kinsella, Chicago, Ill., and Benjamin Nienaber, 800 N. Ninth Avenue, Evansville, Ind.

The Condensed Chemical Dictionary

One of the new editions of extended usefulness to the chemical trades published during the past year was that of the Condensed Chemical Dictionary, second edition, completely revised and enlarged under the supervision of its editor, Thomas C. Gregory, and Isabelle M. Welch, assistant editor. The book is published by the Chemical Catalog Company, Inc., 419 Fourth Avenue, New York. In the preface to the first edition of this work it was pointed out that a surprisingly large number of people not educated along chemical lines have frequent need for detailed information regarding chemicals and chemical products. In the Condensed Chemical Dictionary an attempt was made to collect a mass of information on this subject scattered through hundreds of textbooks, periodicals, government bulletins, etc., as well as to set down certain information that was not known to be anywhere in print. In the preface to the second edition the success of the initial issue was noted. Over 16,000 copies of the first edition were sold to chemists, chemical engineers, metallurgists and other technologists.

This dictionary is published, as noted above, by the Chemical Catalog Company, whose Chemical Engineering Catalog has continued through 15 annual editions and has become a standard reference work. The page size of the Condensed Chemical Dictionary is 6 x 9 inches. There are 550 pages. It is sold by the publisher at $10 per copy.

Coming Meetings

American Ceramic Congress and Exposition, February 23-27 inclusive, 1931, at the Cleveland Public Auditorium, Cleveland, Ohio. Ross C. Purdy, 2525 N. High Street, Columbus, Ohio.

What The World Wants

Specific Inquiries for American Goods Received in the Department of Commerce, Washington, D. C. For further information write the department.

Domestic—49605. Glass-making machinery, including grinders and washers for quartz stones and sands.
France—49279. Glass, laminated.
Canada—49362. Glass protectors, hollow threaded, for fishing buoy lights.
Canada—49508. Glass tumblers, 8 and 9 ounce.
Germany—49658. Glassware, office (desk sets).
Hungary—49751. Glassware, pressed, household, ornamental and bric-a-brac; cut glass; and table and kitchen porcelain.
Brazil—49758. Inkwells, glass.

Readers Wants and Offers

Address answers to all "keyed" ads c/o The GLASS INDUSTRY 24 West 40th St., New York

EXPERIENCED TUMBLER DECORATOR

Wanted: Man with experience in decoration of tumblers with letters and names to be used for advertising purposes. Address "Classified F1."

Current Prices of Glass-Making Materials

January 20, 1931

Quotations furnished by various producers, manufacturers and dealers.

		Carlots	Less Carlots
Acid			
Citric (dom.)	lb.	.40	.40
Hydrochloric (HCl) 20° tanks, per 100 lb		..	1.10
Hydrofluoric (HF) 60% (lead carboy)	lb.	..	.13½
52% and 48%	lb.	.10	.10-.11½
Nitric (HNO_3) 38° carboy ext. Per 100 lb.		5.50	..
Sulphuric (H_2SO_4) 66° tank cars	ton	15.50	..
Tartaric	lb.	..	.31½
Alconol, denatured	gal.	..	.32
Aluminum hydrate ($Al(OH)_3$)	lb.	.04½-.05	.05½-.06
Aluminum oxide (Al_2O_3)	lb.	..	.07
Ammonium bifluoride (NH_4) FHF	lb.	..	.19
Ammonia water (NH_4OH) 26° drums	lb.	.03	.03¼
Antimony, metallic (Sb)	lb.	..	.09¾
Antimony oxide (Sb_2O_3)	lb.	..	.09¾
Antimony sulphide (Sb_2S_3)	lb.	..	.14
Arsenic trioxide (As_2O_3) (dense white), 99%	lb.	.04	.04½
Barium carbonate ($BaCO_3$), Crude, (Witherite) 90%, 99% through 200 mesh	ton	47.00	..
90% through 100 mesh	ton	44.00	..
Barium hydrate ($Ba(OH)_2$)	lb.	..	.05-.05½
Barium mixture, glassmaker's, f.o.b. St. Louis	ton	25.00	..
Barium nitrate ($Ba(NO_3)_2$)	lb.	.03	.03¼
Barium selenite ($BaSeO_3$)	lb.	..	..
Barium sulphate, in bags	ton	19.00	24.00
Barium sulphate, glassmaker's, carlots, bulk, f.o.b. shipping point,	ton	15.00-16.00	18.00
Bone ash	carlots, lb.	.06	.06½
Borax ($Na_2B_4O_7 10H_2O$)	lb.	..	.0355-.0425
Crystal	lb.	.028-.033	..
Granulated	lb.	.025-.03	..
Powdered	lb.	.02875-.03375	..
Boric acid (H_3BO_3)	lb.	.0625-.07125	.06-.08125
Refined	lb.	.0625-.07125	.07125-.08125
Cadmium sulphide (CdS)—			
Red	lb.	..	.70-.90
Orange	lb.	..	.70-.90
Yellow	lb.	..	1.30-1.50
Chromium oxide (Cr_2O_3)	lb.	.24	.26
Cobalt oxide (Co_2O_3)			
In bbls.	lb.	..	1.90
In 10 lb. tins	lb.	..	2.00-2.20
Copper oxide			
Red (Cu_2O)	lb.	..	.25
Black (CuO)	lb.	..	.18-.25
Black prepared	lb.	..	.22
Cryolite ($Na_3Al F_6$) Natural Greenland Kryolith)	lb.	.09	.10-.10½
Synthetic (Artificial)	lb.	..	.09½
Epsom salts ($MgSO_4$) (imported) Per 100 lb.		..	1.15-1.20
Feldspar—			
100 mesh	ton	12.50-20.00	13.50-22.00
80 mesh	ton	11.00-11.75	14.50
40 mesh	ton	11.00	13.50
20 mesh	ton	10.00	10.50
Fluorspar (CaF_2) domestic, ground, 95-98% (max SiO_2 2½%)			
Bulk, carloads, f.o.b. mines	ton	32.50	..
In bags or barrels	ton	36.50	41.50
Imported	ton	36.50	38.50-40.00
Formaldehyde	lb.	..	.07½-.07¾
Graphite (C)	lb.	..	.04-.07
Iron oxide—			
Red (Fe_2O_3)	lb.	..	.0450
Black (FeO)	lb.	.04½	..
Kaolin (f.o.b. mine)	ton	8.00-9.00	..
English, lump, f.o.b. New York	ton	14.50-25.00	24.50-30.00

		Carlots	Less Carlots
Kryolith (see Cryolite)			
Lead chromate ($PbCrO_4$)	lb.	..	30
Lead oxide (Pb_3O_4) (red lead)	lb.	.725-.09¼	.08¼-.09½
Litharge (PbO)	lb.	.625-.08¼	.07¼-.08½
Lime—			
Hydrated ($Ca(OH)_2$) (in paper sacks)	ton	7.75	..
Burnt (CaO) ground, in bulk	ton	6.00	..
Burnt, ground, in paper sacks	ton	8.00	..
Burnt, ground, in 280 lb. bbls.	Per bbl.	2.15	2.30
Limestone ($CaCO_3$)		1.75-2.50	..
Magnesia (MgO)—			
Calcined, heavy (in bbls.)	lb.	.06	.07
light (in bbls.)	lb.	..	.23
extra light (in bbls.)	lb.	..	.27
Magnesium carbonate ($MgCO_3$)	lb.	.06	.07-.10½
Manganese 85% (MnO_2)	lb.	.03	.03
Nickel oxide (Ni_2O_3), black— for nickel content	lb.	..	.35
Nickel monoxide (NiO), green— for nickel content	lb.	..	.35
Plaster of Paris, bags	ton	21.00	23.00-29.00
Potassium bichromate ($K_2Cr_2O_7$)—			
Crystals	lb.	.09	.09¼
Ground	lb.	.11	.12
Potassium carbonate—94-96%	lb.	.0555	.0555
Calcined (K_2CO_3) 96-98%	lb.	.06½	.07¼
Hydrated 80-85%	lb.	.05¾	.06¼
Potassium chromate (K_2CrO_4)	lb.	..	.28-.32
Potassium hydrate (KOH) (caustic potash)	lb.	.07½	.08
Potassium nitrate (KNO_3) (gran.)	lb.	..	.06½-.06¾
Potassium permanganate ($KMnO_4$)	lb.	.16	.17
Powdered blue	lb.	..	.24-.26
Rochelle salts, bbls.	lb.	..	.19
Rouge	lb.	..	..
Rutile (TiO_2) powdered, 95%	lb.	.15-.20	.20-.25
Salt cake, glassmakers (Na_2SO_4)	ton	22.00	..
Selenium (Se)	lb.	..	1.80-1.90
Silver nitrate ($AgNO_3$) (100 oz.)	per oz.	..	.24
Soda ash (Na_2CO_3) dense, 58%—			
Bulk, on contract	Flat per 100 lb.	1.07½	..
In barrels	Per 100 lb.	1.38	1.90-2.00
In bags	Per 100 lb.	1.17½	1.72½
Spot orders.. .025 per 100 lbs. higher		..	..
Sodium bichromate ($Na_2Cr_2O_7$)	lb.	.07	.07½
Sodium hydrate (NaOH) (caustic soda) Solid	Per 100 lb.	2.95	..
Sodium nitrate ($NaNO_3$)—			
Refined (gran.) in bbls.	lb.	.03¾	.04½
95 per cent	Per 100 lb.	1.99½-2.10	2.15-2.25
Sodium selenite (Na_2SeO_3)	lb.	..	2.00
Sodium fluosilicate (Na_2SiF_6)	lb.	.05	.05½
Sodium uranate (Na_2UO_4) Yellow or Orange	lb.	..	1.50-1.55
Sulphur (S)—			
Flowers, in bbls.	Per 100 lb	3.45	3.80-4.00
Flowers, in bags	Per 100 lb	3.10	3.45-3.65
Flour, heavy in bbls.	Per 100 lb.	2.85	3.20-3.40
Tin chloride ($SnCl_2$) (crystals)	lb.	.37½	.39
Tin oxide (SnO_2) in bbls.	lb	.28	.30-.35
Uranium oxide (UO_2) (black, 96% U_3O_8)			
100 lb. lots. Black	lb.	..	2.75
Yellow	lb.	..	1.50
Zinc oxide (ZnO)	lb.	.08½	.12
American process, Bags	lb.	.06½	.07
Zircon			
Granular (Milled .005-.02c higher)		.07	.07¼-.08
Crude, Gran. (Milled .005-.02c higher)		.03¼	.04-.05

Monthly Summary of United States Foreign Commerce in Glass

EXPORTS

Corrected to December 23, 1930

		November 1929 Quantity	November 1929 Value	November 1930 Quantity	November 1930 Value	Eleven Months Ending November 1929 Quantity	Eleven Months Ending November 1929 Value	Eleven Months Ending November 1930 Quantity	Eleven Months Ending November 1930 Value
Glass and glass products (Total)		.....	884,156	.....	701,611	.....	10,088,562	.....	8,423,369
Plate and window glass—									
Window glass, common, box 50 sq. ft.		536	3,709	435	2,002	15,166	[1]89,368	14,782	80,260
Plate glass, unsilvered, sq. ft.		212,472	80,790	300,752	92,617	1,856,852	674,603	3,168,949	984,033
Other window and plate glass	lbs.	459,052	64,652	232,479	24,170	4,375,794	477,679	4,855,675	417,909
Glass containers (bottles, vials and jars)		.....	233,776	.....	193,926	.....	3,318,597	.....	2,783,972
Table glassware, plain		.....	136,378	.....	109,282	.....	1,386,276	.....	1,025,883
Table and other glassware, cut or engraved		.....	16,959	.....	8,829	.....	118,484	.....	89,223
Lamp chimneys and lantern globes	lbs.	104,116	20,666	96,962	16,923	1,504,613	302,666	1,125,686	207,609
Globes and shades for lighting fixtures	lbs.	153,283	54,002	115,020	39,645	1,910,323	687,391	1,481,173	541,349
Chemical glassware	lbs.	32,289	20,059	20,473	15,871	264,813	223,881	248,489	214,335
Electrical glassware, except for lighting	lbs.	256,828	22,629	83,226	7,908	4,726,965	391,615	3,380,738	232,832
Other glassware		.....	230,536	.....	190,438	.....	2,418,002	.....	1,845,964

IMPORTS

Corrected to December 23, 1930

Glass and glass products		.....	1,053,835	.....	634,913	.....	13,113,550	.....	8,333,436
Cylinder, crown and sheet—									
Plain	dut. lb.	3,533,683	125,231	434,860	15,581	64,708,349	2,087,446	14,003,236	547,474
Bent, beveled, colored, etc.	dut. lb.	.....	40,523	.....	23,445	.....	520,885	.....	325,175
Made into mirrors	dut. sq. ft.	.....	.....	8	14	.....	.....	[2]409	[2]900
Plate glass—									
Plain	dut. sq. ft.	1,042,870	201,356	467,876	92,977	10,136,990	2,099,361	4,650,459	925,959
Bent, beveled, colored, etc., and mirrors	dut. sq. ft.	293,442	55,357	19,289	10,516	1,491,909	312,312	572,479	185,265
Rolled cylinder, crown, and sheet glass, ground, obscured, bent, beveled, colored, etc.	dut. sq. ft.	.....	.....	.....	3,340	.....	.....	(2)	[2]22,089
Laminated and plated glass	dut.	.....	.....	.....	213	.....	.....	.....	[2]12,553
Bottles, vials, jars, and other containers	dut.	.....	23,049	.....	75,842	.....	238,922	.....	1,069,442
Scientific articles and utensils	dut.	.....	47,399	.....	29,103	.....	604,887	.....	477,565
Tubes and rods	dut.	.....	.....	.....	12,795	.....	.....	.....	[2]44,340
Illuminating articles	dut.	.....	48,470	.....	45,847	.....	749,150	.....	557,516
Blown glass articles	dut.	.....	387,674	.....	224,336	.....	4,857,910	.....	2,951,124
Pressed glass articles	dut.	.....	12,409	.....	14,651	.....	263,838	.....	193,206
Other glassware	dut.	.....	112,367	.....	86,253	.....	1,378,839	.....	1,020,828

[2] Beginning June 18, 1930.